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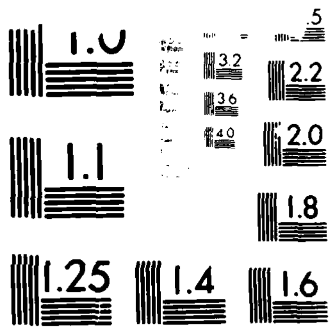
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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

BATTLEFIELD MAINTENANCE AND RECOVERY MODULE
FOR THE AIRLAND RESEARCH MODEL

by

Arild W. Olsen

March 1986

Thesis Advisor: S. H. Parry

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Battlefield Maintenance and Recovery Module for the Airland Research Model

by

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ABSTRACT

This thesis describes a battlefield maintenance and recovery model which will be used in conjunction with the Airland Research Model being developed at the Naval Postgraduate School. It was developed focusing on the two main levels of maintenance in an Army division. These are the organizational level and the direct support level. Its main area of emphasis is to determine the impact maintenance and recovery have on the combat value of a unit. It investigates the difference in two maintenance concepts. The first one being recover and return to the rear area for repair and the second being fix forward.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to develop a battlefield maintenance and recovery module (MRM) for inclusion in the Airland Research Model (ALARM). This module will be developed focusing on the two major levels of maintenance support on the battlefield; organizational maintenance and direct support maintenance. It will enable the Airland Research model to assess the impact on combat battlefield maintenance and recovery. Currently there are two different methodologies being considered. The first is the concept of fix forward; the second being recover and repair in the rear area.

1. Recovery and Evacuation

Battlefield recovery and evacuation can be a manpower intensive, time consuming endeavor. Current modelling methodologies rarely consider this as one of the variables involved in returning a disabled piece of equipment to the battlefield. Recovery is primarily the removal of a damaged piece of equipment from the battlefield by an external source to an area where it can be repaired. This external source can be either a like vehicle or a recovery vehicle such as a heavy equipment transporter (HET). The area where it can be repaired is usually the unit field trains which consist of the logistics personnel of the battalion. This would include the supply and maintenance personnel on the organization level.

Evacuation is the transfer of a disabled piece of equipment to a higher maintenance echelon. This is usually the transfer of equipment from the organizational to the direct support level of maintenance. Regardless of whether a unit is performing recovery or evacuation it requires a

large number of personnel and recovery assets for an extended period of time. In a scenario such as the European environment, the time factor will be critical when we are fighting outnumbered. Therefore what is needed is a way to assess the combat value of a maintenance program which utilizes the fix forward concept as much as possible versus the combat value of a program which recovers and repairs in the rear.

2. <u>Fix Forward</u>

The fix forward concept entails attaching a maintenance support team of five to twenty mechanics, depending on the size and mission of the supported battalion. It will also include an initial stockage of repair parts dependent on the density of equipment types which the battalion possesses. The advantage of this maintenance concept is that it allows the mechanics to be where the equipment is and to repair it where it is damaged. This relieves both the supported battalion and the supporting maintenance company of the problem of having to recover the equipment in order to get it repaired. The disadvantage of this concept is that it will divide the supporting maintenance company assets into four or five segments, depending on the number of battalions they are supporting, thus increasing the amount of command and control necessary to insure the effective and efficient operation of all elements. It will also split the stockage of repair parts and make it more difficult to insure the parts are located where they are needed.

3. <u>Recover and Repair</u>

The concept of recover and repair has been the mainstay of current maintenance doctrine. In this concept all damaged equipment is recovered or evacuated from the battlefield and taken to the appropriate maintenance facility for repair. The advantage of this concept is that all mechanics and repair parts are centrally located so that there is no

possibility of one unit having a surplus of maintenance capability and another having a shortfall. All assets are under the direct command and control of the maintenance company commander and are responsive to any change in the tactical situation. The primary disadvantage of this concept is that it requires the additional time to recover equipment and then to return the equipment after repair. Also it requires additional personnel and recovery assets that may not be neccessary if maintenance assets were available on site.

4. Objectives of Research

Research for the MRM considered different modelling methodologies for its development. The objectives of the research for the MRM are as follows.

a) Determine levels and methods for aggregation and/or disaggregation.

b) Obtain a data base for the MRM.

c) Integrate maintenance and recovery into the transportation network methodology.

d) Build a simulation model of battlefield maintenance and recovery.

B. MAINTENANCE SUPPORT OVERVIEW

1. Maintenance Definition

Maintenance as defined by FM 100-10 (Combat Service Support) consists of all actions taken to retain material in a serviceable condition or to restore it to serviceability. Doctrine has indicated that in the Airland Battle U.S. forces will be fighting outnumbered. Thus it is imperative that we recover and return to serviceability all damaged and disabled equipment as soon as possible. The concept of "fix forward" needs to be integrated into the total maintenance picture. This concept will help to maximize weapons system combat time by reducing or eliminating the time required for recovery and evacuation. Battlefield recovery and evacuation is defined as the process of retrieving

inoperable or battle damaged equipment from forward areas to the supporting maintenance activity for repair (either unit field trains or a supporting direct support maintenance activity). Utilization of a fix forward concept would require the commitment of a substantial amount of maintenance capability (mechanics and repair parts) in the actual battle area.

2. Returning Disabled Equipment to Serviceability

Returning a disabled or battle damaged piece of equipment to serviceability normally requires two interdependent actions to take place. These are a maintenance action, which entails personnel and equipment, and a supply action.

The maintenance action can be divided into various subtasks such as:

a) Inspection and classification of equipment
b) Repair of equipment
c) Testing of repaired equipment

The supply action can also be divided into various subtasks such as:

a) Receipt, storage and issue of repair parts
b) Direct exchange
c) Operational readiness float (ORF)
d) Controlled exchange and cannibilization

All of these tasks are interrelated in one way or another and cannot function alone on a battlefield.

3. Inspection and Classification

The inspection and classification of a disabled piece of equipment is done in order to accurately ascertain the extent of damage and the repairability of the equipment. The initial assessment is done by the owning unit's organizational mechanics. They will determine if the equipment can be repaired at their level with the repair parts and skill levels they possess. If the mechanics determine that they do

not have the capability to repair the item, they will contact their supporting direct support maintenance company for a formal inspection and classification. This entails a formal procedure by which the inspector determines the extent of damage and the repair parts required to restore it to serviceability. If the damage is extensive the inspector will then determine if the equipment is economically or uneconomically repairable. If it is determined to be uneconomically repairable, it is then removed from the inventory of the owning unit and placed in a cannibilization status where any serviceable components can be removed.

4. Repair of Equipment

After the extent of damage has been determined and the appropriate repair parts have been obtained, a crew of mechanics will repair or replace components of the damaged equipment according to the inspection sheet. The type of mechanic utilized for the repairs depends on the system or components damaged. The number of mechanics used also depends on the component damaged.

5. Testing of Repaired Equipment

Upon completion of repairs by the maintenance crew the piece of equipment is returned to the inspection section. There it is determined if the correct repairs were made and whether the equipment has been returned to a serviceable condition. When this has been determined, the supporting maintenance unit will notify the owning unit to pick up the equipment.

6. Receipt, Storage and Issue of Repair Parts

The receipt, storage and issue of repair parts is one of the most critical functions of a maintenance unit. If the correct repair parts are not on-hand or if they cannot be obtained in an expedient manner, the maintenance unit cannot repair damaged equipment. Each company in the Army has a precribed load list (PLL) of repair parts. This list

depends on the type of equipment a unit has and on the densities of this equipment. It is a listing of those repair parts required to be on-hand by the unit in order to sustain it in a combat situation for thirty days and is determined through historical records of the equipment on-hand and their consumption of repair parts.

At the direct support level of maintenance the combat divisions have an authorized stockage list (ASL) which is a listing of repair parts and major assemblies required to be on-hand. The major assemblies are engines, transmissions, transfers, axles, final drives, etc. The division ASL supplies all the repair parts for the entire division. It is used to replenish the PLL of individual companies and forms a basis for the direct support stockage of repair parts for the division maintenance battalion. The division ASL is maintained by the divisional maintenance battalion in a central warehouse. Each line item of stockage is tracked to insure that there are always supplies on-hand. As an item is ordered from the warehouse it is annotated as in a checking account. When the balance of the item on-hand reaches the reorder point, a requisition is sent to the next higher stockage point to replenish it to its authorized level. These stockage levels and reorder points are computed to allow the division an average thirty day stockage of repair parts.

7. <u>Direct Exchange</u>

The direct exchange (DX) system is used to augment the division's ASL and the company's PLL. It consists of those repair parts that can in themselves be repaired rather than just replaced. These items consist of things such as generators, alternators, carburetors, fuel injection pumps, etc. They are requisitioned the same as repair parts, except that the damaged item must be turned in for repair.

8. Operational Readiness Float

The operational readiness float (ORF) of a division consists of a collection of major end items: tanks, trucks, armored personnel carriers, etc. They are utilized only as a wartime stockage reserve. If a damaged piece of equipment is determined to be uneconomically repairable and removed from the owning unit's inventory it will be replaced by a like item from the division float assets. A new end item will be requisitioned and when received will be placed in the float. This is done primarily so that a unit will not be short any equipment which will degrade its combat effectiveness.

9. Controlled Exchange and Cannibalization

Controlled exchange and cannibalization are a last resort for obtaining repair parts. Cannibalization is the removal of serviceable repair parts from an uneconomically repairable item of equipment. Controlled exchange is the removal of serviceable repair parts from a like piece of equipment that is disabled for another reason, which results in getting one item in a combat ready posture at the expense of another. Both of these are actions of last resort because they entail doubling the workload of repairing an item.

C. MAINTENANCE ECHELONS

1. Echelon Definition

The U.S. Army currently uses a system of four maintenance echelons. These levels of maintenance are:

a) Organizational (operator and unit)
b) Direct Support
c) General Support
d) Depot

Proposals for doctrinal changes in maintenance support as specified in the Airland Battle 2000 concept would reduce the number of maintenance echelons to two. The proposal is to combine organizational and direct support as

one echelon, and general support and depot repair as the second echelon. Since the Airland Research Model is structured at a corps level, the two primary levels of maintenance support which will be utilized in the maintenance module will be the organizational level and the direct support level.

2. <u>Responsibilities</u>

The organizational level of maintenance is characterized by preventive maintenance and replacement of direct exchange type repair parts, i.e., carburetors, distributors, tires, etc. In a combat situation these actions would be limited to mission essential maintenance only (MEMO) which is defined as only that maintenance required to keep a vehicle operationally ready for a given mission.

The direct support level of maintenance is characterized by the replacement of major components of weapon systems, i.e., engines, transmissions, final drives, tank tubes, fire control equipment, etc., the evacuation of damaged equipment to higher levels of support, backup recovery support and repair parts supply.

D. PROBLEM DEFINITION

What is needed is a prescriptive model which will explicitly simulate battlefield maintenance and recovery. There are two models which are currently being utilized to simulate combat service support operations in a combat environment. These are the ARMY UNIT READINESS/SUSTAINABILITY ASSESSOR (AURA) Model and the combat service support module in the FORCE COMBAT EVALUATION MODEL (FORCEM). Maintenance support in both these models are explicit, sequential event type models. These two models differ greatly in their degree of resolution in simulating battlefield maintenance and recovery. AURA is a very high resolution model while FORCEM is a low resolution model.

FORCEM is a theater level combat model. Its simulation of maintenance and recovery is one of low resolution. It is a deterministic model and uses expected value data. The maintenance routines in this model are called only once every 24 hours of simulation time. It is considered a low resolution model for maintenance and recovery for several reasons:

a) Representation of equipment

b) Representation of personnel

c) Representation of repair, repair parts and repair parts supply

d) Maintenance asset attrition

The representation of equipment in FORCEM assumes that all vehicles will fall into a general vehicle class. For example, all trucks two and a half tons and heavier will be represented as similar vehicles utilizing the same mechanics and repair parts. The representation of personnel in FORCEM assumes that all maintenance personnel possess all requisite skills to complete any maintenance task. Repair parts are represented by tonnage, i.e., a certain vehicle class will require a specified tonnage of repair parts, and in order for the vehicles to be repaired, that many tons of repair parts must be available. The final assumption is that maintenance asset attrition can occur only at their base location, which means they are invulnerable when performing recovery missions or when support elements are fixing forward.

According to the AURA users manual, "AURA is a Monte Carlo discrete event simulation model intended for analyzing the interrelationships among the resources associated with a set of combat units, and the capabilities of those units to generate combat missions in a dynamic and rapidly evolving wartime environment." It is a very high resolution model which simulates vehicle maintenance, repair parts supply, support repair jobs and recovery.

In contrast to the FORCEM model it provides for repair parts in terms of the actual parts required, (i.e., normal receipt and issue, direct exchange, cannibalization or controlled exchange). Maintenance personnel are allocated by the particular "shop" in which they work. AURA provides for thirty possible maintenance shops within a maintenance organization. AURA's actual maintenance tasks that can assigned to these shops include:

1) Unscheduled maintenance
2) Pre-mission tasks
3) Battle damage repair tasks
4) Other related vehicle tasks (Refueling, rearming,etc)

Each of the sub tasks in these areas can be defined as one-step or multi-step procedures depending on user input. The actual maintenance decision processes are explicitly represented in this model. The majority of the program is user defined inputs or functions such as equipment inventories, repair parts inventories, maintenance skill definition, force structure and maintenance and supply decision doctrine.

These two models explicitly represent the "real world" processes. What is needed for the Airland Research Model is to find a compromise in resolution between these two models that would provide an accurate depiction of maintenance support but without an immense data base. Another goal for the MRM is to develop appropriate stochastic processes and their parameters for combat maintenance support if at all possible. If so, it would provide a prescriptive capability for the Airland Research Model which would represent maintenance support under combat conditions in conjunction with the overall combat model.

This thesis is divided into five chapters and two appendices. Chapter one has provided an introduction and an overview of maintenance support. Chapter two deals with the

module design concepts utilized in the construction of the MRM. Chapter three is an analysis of the combat damage data from the Southeast Asia conflict and the Yom Kippur war. Chapter four is a detailed step through of the decision logic and routines utilized by this model. Chapter five is an analysis of the model output and and the resulting conclusions that were formulated. Appendix A is the program listing of the tank maintenance and recovery routines. The other three vehicle routines were omitted for brevity. Appendix B explains the variables utilized in the program.

II. MODULE DESIGN CONCEPTS

A. RESOLUTION

As previously stated, the major concern regarding the inclusion of a maintenance support module into a corps level combat model is what level of resolution is required. Constrained by storage capabilities and computer run time, a module as highly resolved as AURA would not be practical for use in the Airland Research Model. However a low resolution module such as that found in FORCEM would not give an adequate depiction of maintenance support and its impact on the rest of the model.

The resolution of maintenance support can be divided into three areas. The first is the representation of the various types of vehicles present on the battlefield today, secondly is the representation of all the different repair parts that will be utilized by these vehicles, and thirdly the different types of specialized repair personnel that are currently being trained and utilized in the maintenance field must be represented.

1. Vehicle Representation

The resolution required in the representation of vehicles on the battlefield must accurately depict the major combat power and transportation assets of the unit being modeled. It must be detailed enough to represent the major portion of the vehicle assets available to the unit but general enough so that the data base requirements for the repair parts of these vehicles will be minimized.

The resolution that will be used in the MRM for vehicles will be the same as that used in the FORCEM model. The MRM will represent general vehicle classes and will base the repair parts assets and the mechanics required on these different classes. This representation, although very

general, will meet the attributes mentioned above in that it will represent the major portion of the vehicle assets in the unit but will simplify repair parts representation.

2. Repair Parts Representation

The level of resolution in representing repair parts in the MRM will be somewhere between the representations in AURA and FORCEM. It will be more closely related to AURA in that specific repair parts will be represented as opposed to FORCEM which utilizes tonnage of repair parts. The MRM will represent many of the major assemblies that are replaced at the Direct Support level of maintenance i.e., engines and transmissions. It will not go to the level of detail that AURA does in representing direct exchange and controlled substitution. That level of resolution for this model is not desired or required. By representing only the major assemblies as repair parts we capture the majority of those repairs that affect mobility and firepower in a vehicle.

3. Maintenance Personnel Representation

In the MRM the different types of mechanics that will be utilized by a Maintenance Support Team (MST) or a Direct Support maintenance company will be represented. Since the representation of repair parts will be limited to the major assemblies we need only to represent the mechanics that will repair or replace these assemblies. This level of resolution is between the levels of AURA and FORCEM. FORCEM represents only a mechanic who can repair all damages, AURA represents twenty five separate shops and their mechanics which cover almost any type of repair that would be required.

4. Overall Level of Resolution

As mentioned above, the three categories of vehicles, repair parts and mechanics all affect the overall level of resolution of a simulation. These three categories can be multiplicative with respect to each other. An

increase or decrease in one category can affect the magnitude of the other two categories, so that in determining an overall level of resolution all three categories need to be considered together.

B. STRUCTURE

Battlefield maintenance and recovery during a corps level field exercise is a fluid activity rather than a static one. In order to accurately portray maintenance support, it must be an integral and continual part of the combat model.

The MRM will be structured so that it can be run off-line from the main combat model (ALARM). It will then be available for use at any time during the execution of the main model. The Airland Research Model will provide inputs to the MRM. These inputs will be the number of vehicles by category that have been damaged during the course of a battle and their location on the battlefield.

1. Vehicle Categories

There are four categories of vehicles in the initial maintenance module. These categories were selected because they represent the majority of vehicles in the Army inventory and the actual maintenance requirements within each category for different types of vehicles are very similar. For example, the number of mechanics and the amount of time required to repair an engine on a 5 ton versus a 2 1/2 ton truck are the same. The categories selected are:

a) Tanks

b) Armored Personnel Carriers

c) Wheeled vehicles

d) Artillery pieces

These categories represent the major portion of the combat systems that will be present on the battlefield, and are equally representative of either an armored or an infantry division.

2. Maintenance Entities

. The actual maintenance entity in this model will be represented by a mechanic. The mechanic types that are utilized are:

a) 63C - Tank vehicle mechanic
b) 63H - Wheeled vehicle mechanic
c) 45K - Armament mechanic
d) 45C - Fire control mechanic
e) 63G - Fuel/electrical mechanic

These military occupational specialties (MOS) were selected for the initial runs of the model because they represent the major portion of a direct support maintenance company and the major portion of an organizational motor pool.

3. Repair Part Categories

The selection of the repair parts to be modeled was based on the vehicle categories selected. These repair parts represent the major assemblies of these vehicles and are the components which most directly affect the mobility and firepower of the vehicle. Because of the similarity of the components of the tracked vehicles, the categories of tanks, armored personnel carriers and artillery pieces will all utilize the same type of repair parts. These are:

a) Engine
b) Transmission
c) Transfer
d) Final drive
e) Track
f) Fire Control System
g) Armament System
h) Electrical System

The wheeled vehicles represented in this model utilize four types of repair parts. These are:

a) Engine

b) Transmission

c) Transfer

d) Axle/Suspension System

These categories of repair parts for the wheeled and tracked vehicles represent the major portion of those repairs that would be neccessary in a combat environment to maintain them in a combat ready status. This representation allows the monitoring of specific repairs and repair parts rather than just tonnages of repair parts as is done in the FORCEM model. It is also not as complex or intensive as the AURA model but allows an accurate portrayal of battlefield maintenance at a level of resolution compatible with the Airland Research Model.

C. PRIORITIZATION

1. Vehicle Type Priority

Standard Army doctrine designates a priority listing for repair work. This listing is based on what the Army defines as 'pacing' items. Pacing items are those major end items which provide the main combat power of a unit. For example, the pacing item for an armored battalion is a tank, for an infantry unit it is an armored personnel carrier, and for an artillery battery it is their howitzers. These three items of equipment would receive priority of repair over all other pieces of equipment within those three types of units. For the purpose of this model, these three pacing items are the only three utilized, however within these three there is also a prioritization. The priority of repair utilized by the model is:

a) Tank vehicles

b) Artillery pieces

c) Armored personnel carriers

d) Wheeled vehicles

2. Hierarchical Priority

As previously discussed, vehicles within an organization are prioritized for repair work. Concurrently, organizations themselves can be prioritized for repair work. This will work in conjunction with the Generalized Value System. Each element of a division has some value associated with it depending on its mission, its strength, its location on the battlefield and its operational capability. This value can be used as a discriminator in determining priority of repair.

3. Utilization

These priorities will come into play if demand for repair exceeds maintenance capability. If the number of mechanics required exceed the number available, the items requiring repair will go into the appropriate queue. The queues will be prioritized according to vehicle type and unit hierarchy. These queues can then be changed by the user if the situation dictates. This will occur in the hierarchical priority as the value of a unit changes as its mission changes. The prioritization by vehicle can also change if the operational readiness of a specific weapon system drops below a predesignated threshold level. The operational readiness of a vehicle is defined as the number of combat ready vehicles (by type) divided by the total number of vehicles (by type). This will give an availability percentage by vehicle type. This percentage will generally range between 0.50 and 0.70. For example, if the predesignated rate for armored personnel carriers was 0.70 and the operational readiness rate for them was calculated to be 0.60 then priority of repair would be shifted to armored personnel carriers until its readiness rate was above the threshold level.

D. ALLOCATION OF MAINTENANCE SUPPORT TEAMS

Each maneuver battalion and artillery battalion is allocated a direct support maintenance support team (MST) to be deployed forward along with the unit's field trains. Their mission will be to repair those items of equipment that are considered fast turnaround repairs. A fast turnaround repair is defined as any repair job that can be completed within four hours by a crew of two or three mechanics. Fast turnaround repairs will be utilized for those jobs that can be repaired on-site in order to eliminate recovery time. The maintenance support teams will be under the operational control (OPCON) of the supported unit but will receive all class IX (repair parts) direct support supply from their organic maintenance company.

The MST will function independently of the Direct Support maintenance company in the rear and will complete all repairs within their capability. This capability depends on two factors. The first factor is the number of mechanics in each area that the support team has and the second is the repair time criteria mentioned above. As an example, if the MST has ten mechanics available for repair and the repair time criteria is eight hours it equates to a repair capability of eighty manhours. This would then be utilized in determining evacuation criteria for the MST. This criteria is determined based on the desired allowable workload above the repair capability. The evacuation decision may be to evacuate any repair job which would exceed the repair capability of the MST, or it could be set at some multiple of the repair capability. As in the example above, the evacuation criteria could be set at two times the repair capability which would mean all repair work up to 160 manhours of repair would remain at the MST and anything in excess of this would be evacuated to the DS maintenance company in the rear.

E. BATTLE DAMAGE ASSESSMENT

The Airland Research Model (ALARM) will provide the MRM with the number of vehicles, by type, that have been damaged during the course of a battle. The MRM will then take these numbers and assess specific repair requirements for these vehicles. It will first determine how many of the vehicles have been completely destroyed and then determine how many of the damaged vehicles will require engines, transmissions, etc. It will do this through an empirical distribution obtained from actual combat data from the Yom Kippur War and the Southeast Asia conflict. An example of the combat data from these conflicts along with an analysis of that data is provided in Chapter 3.

III. COMBAT DATA ANALYSIS

A. DESCRIPTION OF DATA

The combat data that was utilized in the MRM was obtained from the Combat Data Information Center of the Air Force Wright Aeronautical Laboratory located at Wright-Patterson AFB in Ohio. The data obtained consisted of two separate databases. One was the Southeast Asia Ground Vehicle Database and the other was the Arab-Israeli Conflict (1973) Database (Yom Kippur). These databases were analyzed to determine an empirical distribution of combat damage to be utilized in the maintenance module of the Airland Research Model.

1. Southeast Asia Ground Vehicle Database

This database is a collection of 706 Army ground vehicle reports prepared by a 47-man Battle Damage Assessment and Reporting Team in Southeast Asia. It contains the details of individual combat incidents in which loss or damage occurred. An example of the data is shown in Figure 1.

The types of vehicles analyzed for utilization in the damage distribution of this model were armored personnel carriers, tanks, wheeled vehicles and artillery pieces. The information extracted from the separate incidents include model type, direct and indirect hits, hit location, threat type, repair level and manhours if available, and the systems that were damaged. The types of weapons that were used against this equipment were classified into six categories: mines, rocket propelled grenades, mortar and rockets, machine guns, small arms, and grenades.

2. Arab-Israeli Conflict (1973) Data Base

The database from the 1973 Arab-Israeli conflict was collected by the Weapons Systems Evaluation Group (WSEG) in

MODEL	MATERIAL TYPE REPAIR STATUS	MOD OD REPAIR LVL	DIR HITS	IND HITS REPAIR M/H	OPS IMPACT HIT LOCATION	SYSTEMS DAMAGED
M48	TANK RECOVERED	568 DEPOT	02	00	RENDERED INOPERABLE TRACK	WHEEL SUSPENSION TRACK FRAME
M113	ABANDONED	553	01	00	SCRAPPED HULL	TOTALLY DEST
M113	RECOVERED	553 CONUS	01	00	RENDERED INOPERABLE TRACK	TRACK WHEEL TRANSMISSION SUSPENSION DRIVE TRAIN CUPOLA HULL MAIN ARMAMENT ENGINE FUEL TANK
M113		553	01	00	SCRAPPED HULL	TOTALLY DEST
M113		553	04	00	SCRAPPED HULL/WHEEL/TURRET	TOTALLY DEST
M113	RECOVERED	553 DEPOT	01	00	RENDERED INOPERABLE TRACK	FRAME SUSPENSION DRIVE TRAIN WHEEL

Figure 3.1 Southeast Asia Data Base Example.

conjunction with representatives of the Israeli Defense Force. It consists of a total of 774 reports describing damage to individual vehicles (577 tanks and 197 armored personnel carriers). The information that was extracted from this database consisted of type of vehicle, general hit location, component of initial impact, and component of subsequent impact.

B. TANK DAMAGE DATA

Analysis of the tank data from these two databases produced a total of 257 separate combat incidents in which the vehicle involved was either totally destroyed or one or more of the repair parts or components being modeled were damaged. From these 257 incidents there were a total of 425 separate components damaged. A breakout of the total damages by component is given in Table 1.

TABLE I

TANK DAMAGES BY COMPONENT

1) Tanks totally destroyed	- 70
2) Engines damaged	- 27
3) Transmissions damaged	- 37
4) Transfers damaged	- 25
5) Fire control system damaged	- 37
6) Electrical system damaged	- 49
7) Armament system damaged	- 44
8) Track damaged	- 136
Total systems damaged	425

The number of damages for each component were then divided by the total number of vehicles damaged to get a relative percentage of the amount of damage each system had sustained. These percentages when summed are greater than one which reflects the fact that a single tank can have more than one component damaged. This raw data was then normalized over the total number of systems damaged to obtain an

ized over the total number of systems damaged to obtain an empirical probability density function of combat damage by system. A breakdown of the raw data and the resulting empirical probability density function are given in Table 2.

TABLE II

TANK DAMAGES PROBABILITY DENSITY FUNCTION

System or component	Percentage Damaged	Probability Density Function
Totally destroyed	.27237	.16471
Engine	.10506	.06353
Transmission	.14397	.08706
Transfer	.09728	.05883
Fire control system	.14397	.08706
Electrical system	.19066	.11529
Armament system	.17121	.10353
Track	.52918	.31999

The data appear to be relatively uniform across systems except for the amount of damage done to the track components of a tank. This is, however, intuitively as one would expect as the track components of a tank are the most vulnerable and therefore the components most susceptible to damage. This empirical density function for the combat data of tank systems closely approximates actual combat damage as experienced during the Southeast Asia conflict and the Yom Kippur War.

C. ARMORED PERSONNEL CARRIER DAMAGE DATA

The combat damage data extracted from the two databases on armored personnel carriers included all types of the M113 series of vehicles. This included vehicles such as the M577 Command Track, M578 Artillery cargo vehicle and the M901 Improved TOW vehicle. These were included because they all utilize the same chassis and drive train. The only

significant difference among these vehicles is the configuration of the armament and fire control systems. Since this model represents these systems as a whole and not by specific component, it was therefore appropriate to consider all these systems as a single type vehicle. Analysis of the two data bases produced a total of 372 separate incidents which involved the total destruction of the personnel carrier or one or more damages of the components being represented in this model. Of those 372 incidents there was a total of 601 separate components damaged. A breakout of those damages are given in Table 3.

TABLE III

APC DAMAGES BY COMPONENT

1) APCs totally destroyed	-	91
2) Engines damaged	-	84
3) Transmissions damaged	-	77
4) Transfers damaged	-	62
5) Fire control system damaged	-	10
6) Electrical system damaged	-	29
7) Armament system damaged	-	32
8) Track damaged	-	216
Total systems damaged		601

The combat damage data were then treated in the same manner as the tank damage data. The resulting damage percentages and the probability density function is given in Table 4.

Analysis of this probability density function results in approximately the same conclusion as the tank damage data. The damages are relatively consistent across the components with the exception of the track which again is the most vulnerable component.

TABLE IV

APC DAMAGES PROBABILITY DENSITY FUNCTION

System or component	Percentage Damaged	Probability Density Function
Totally destroyed	.24462	.15141
Engine	.22581	.13977
Transmission	.20699	.12812
Transfer	.16667	.10316
Fire control system	.02688	.01664
Electrical system	.07796	.04825
Armament system	.08602	.05324
Track	.58065	.35940

D. WHEELED VEHICLE DAMAGE DATA

The combat damage data extracted from the two databases on wheeled vehicles included data from all wheeled vehicle types with the exception of low density engineer equipment such as scoop loaders and backhoes. These types of equipment do not fall into the category of main combat power or transportation asset for a unit and for that reason were omitted from the analysis. There were a total of 78 separate wheeled vehicle incidents in these two databases with a total of 104 separate component damages. A breakdown of the component damages is given in Table 5.

These data were then treated the same way as the personnel carriers and tanks with the resulting percentages of damage and probability density function given in Table 6.

Analysis of these results show that the damages sustained by a wheeled vehicle are relatively uniform across all components which suggests that all components of a wheeled vehicle are equally susceptible to damage.

TABLE V

TRUCK DAMAGES BY COMPONENT

1) Trucks totally destroyed	-	14
2) Engines damaged	-	20
3) Transmissions damaged	-	24
4) Transfers damaged	-	21
5) Axle/Suspension damaged	-	25
Total systems damaged		104

TABLE VI

TRUCK DAMAGES PROBABILITY DENSITY FUNCTION

System or component	Percentage Damaged	Probability Density Function
Totally destroyed	.17949	.13462
Engine	.25641	.19231
Transmission	.30769	.23077
Transfer	.26923	.20192
Axle/Suspension	.32051	.24038

E. ARTILLERY DAMAGE DATA

The database for artillery component damages was very small. There was only a total of 11 separate artillery pieces which were either destroyed or damaged. Of these 11 there was a total of 18 components damaged. Although it was a very small sample compared to the other three vehicle systems the data were handled in the same manner. The vehicles included in this category were the M109 and M110 Self Propelled Howitzers. The breakdown of the combat damages are given in Table 7.

TABLE VII

ARTILLERY DAMAGES BY COMPONENT

1)	Howitzers totally destroyed -	1
2)	Engines damaged -	3
3)	Transfers damaged -	1
4)	Fire control system damaged -	1
5)	Electrical system damaged -	3
6)	Armament system damaged -	5
7)	Track damaged -	4
	Total systems damaged	18

The resulting damage percentages and probability density function are given in Table 8.

TABLE VIII

ARTILLERY DAMAGES PROBABILITY DENSITY FUNCTION

System or component	Percentage Damaged	Probability Density Function
Totally destroyed	.09091	.[illegible]5
Engine	.27273	.[illegible]6667
Transfer	.09091	05555
Fire control system	.09091	.05555
Electrical system	.27273	.16667
Armament system	.45455	.27778
Track	.36364	.22222

Because of the small sample size many of the values in the empirical probability density function are repetitive. These values, however, appear to be as expected in that half of the total damages were between the armament system itself and the track.

F. DISCUSSION OF DATA

Although the values in the probability distribution functions are not to be considered as absolutes in determining combat damages in simulation modelling, they are based on historical figures and as such are probably more reliable than numbers obtained from other sources. These values when utilized by the MRM will reasonably represent the damages that would be expected to appear in a real life combat situation and should realistically reproduce combat damages.

IV. MODULE DECISION LOGIC AND DESIGN

A. INTRODUCTION

This chapter describes the decision logic utilized in MRM and provides an explanation of the various queues used throughout the program. It provides a step-by-step description of the maintenance and recovery algorithms and decisions. The general processes involved are identified and described and the structure of the model components and their interrelationships are discussed in detail. The actual decision logic and routines throughout this simulation are identical for all four categories of vehicles that are modeled. This description of the logic and design of the model will refer to only the tank maintenance and recovery routine for brevity but applies universally to all four maintenance and recovery routines. Any differences which are present in the module as a whole will be addressed as neccessary.

1. Maintenance and Recovery Queues

For each repair part in the MRM there are a total of six queues. These queues are:

a) Under repair
b) Waiting mechanics
c) Waiting parts
d) Return time
e) Evacuation to rear
f) Repaired and returned

These queues represent the various dispositions that a vehicle can be in at any given time. For the armored personnel carriers, tanks and artillery pieces (which have eight separate repair parts represented) there are a total of forty eight queues each. The wheeled vehicles with four repair parts represented have twenty four queues. This

amounts to a total of 168 queues being utilized by this model for the vehicles. There are also two other queues which handle the evacuation times for the two maintenance support teams (MST) for a total of 170 queues for the MRM.

a. Under Repair Queue

This queue contains all those vehicles for which there were sufficient repair parts on-hand and enough mechanics available to repair them.

b. Waiting Mechanics Queue

This queue contains all those vehicles for which there were parts on-hand but there were not enough mechanics available to perform the required repairs. When this queue is entered the appropriate repair part is decremented from the repair parts stockage so that when mechanics become available it will automatically transfer to the Under Repair queue.

c. Waiting Parts Queue

This queue contains all those vehicles for which there were not sufficient repair parts available. Vehicles in this queue remain there regardless of how many mechanics are available. This will be the first possible queue that a vehicle requiring repair can enter.

d. Return Time Queue

This queue relates the time that vehicles will be completed with their repairs. It is entered at the same time a vehicle enters the Under Repair queue and is then checked continually against the current simulation time to determine if repairs are completed. On completion, the vehicles are transferred to the repaired and returned queue.

e. Repaired and Returned Queue

This queue contains all those vehicles that have been placed under repair and have been completed. These vehicles are considered to be available for return to the owning unit as a completely functional vehicle.

f. Evacuation Time Queue

This queue contains the time of arrival of vehicles evacuated from the forward maintenance support teams to the Direct Support maintenance company. It relates evacuation time to current time and will be integrated with the transportation network module which will determine the time delay inherent in transporting pieces of equipment from the front battle areas to the rear area. Currently the time delay is a user supplied input to the MRM.

g. Evacuation to Rear Queue

This queue is entered at the same time as the evacuation time queue but keeps track of the total vehicles being evacuated from the maintenance support teams to the DS maintenance company.

B. STRUCTURE

The maintenance and recovery module is a discrete event simulation model. It has been initially run using a time step of one hour. The program is designed however, to accomodate any time step a user would care to designate. As an example, if the time step desired is 12 hours the various time parameters in the model such as evacuation time, or repair and return time would be adjusted to reflect the 12 hours in terms of days. (i.e. instead of a 6 hour evacuation delay it would be reflected as a 0.25 day delay.) As such, any time step can be utilized by the model with minimal code modification.

1. Initialization of Model (See Section 1, Appendix A)

The initialization of MRM allows the user to specify various configurations of maintenance support. The model has three distinct maintenance elements represented; designated as a Direct Support maintenance company and two forward deployed maintenance support teams. The strength and composition of these three elements can be changed and varied according to the desires of the user. The user may elect to

conduct all maintenance in the rear Direct Support company by initializing the number of mechanics in the forward maintenance support teams to zero. This would result in all repair jobs located in the forward areas to require evacuation and would therefore incur a time delay. Similarly the user may elect to have a large portion of the total maintenance capability in the forward deployed maintenance support teams. The user then has the ability in MRM to change the number of mechanics in each element and the composition of those elements.

a. Types of Mechanics

The simulation utilizes five different types of mechanics: tank mechanics, wheeled vehicle mechanics, armament mechanics, fire control mechanics, and electrical mechanics. Each type of mechanic has its own set of repair jobs that it can accomplish. As opposed to FORCEM which assumes that each mechanic can perform repairs in all categories, MRM allows for no cross-utilization of mechanics between maintenance categories. This was done because it more accurately depicts the actual capabilities of the mechanics in the field today.

Only two of the five mechanic types represented in MRM can perform more than a single type of repair: the tank mechanic and the wheeled vehicle mechanic. The tank mechanic can perform five different types of repairs: engines, transmissions, transfers, final drives and track. He can repair these five components on tanks, armored personnel carriers, and self propelled howitzers. As such this mechanic, as in a real maintenance unit, is the largest group of mechanics. In MRM the tank mechanic is utilized in three of the four routines. The wheeled vehicles have their own mechanic which can perform all the repairs represented for wheeled vehicles, i.e. engine, transmission, transfer and the axle/suspension system. The other three mechanic types handle one repair each, either the electrical, fire

control or armament systems, but they can repair them for all three tracked vehicle categories.

b. Allowable Workload Initialization

One of the determining factors in the evacuation decisions of this model is the allowable workload of the two forward deployed maintenance teams. The allowable workload is in units of manhours per type of mechanic in the team. This means that there is a different value for each mechanic type in each of the two forward teams. These values can be adjusted by the user to reflect different evacuation policies. Depending on the number of mechanics in each team the allowable workload would indicate how much of a backlog of maintenance repair in manhours is going to be allowed before the damaged vehicles must be evacuated to the rear Direct Support company.

c. Initial On-hand Quantities of Repair Parts

The initialization of the on-hand quantities of repair parts in each of the three maintenance elements can be utilized to represent different maintenance policies. If only those repairs that take less than a certain amount of time to repair are to be completed by the forward teams, then those repair parts would be the only ones stocked. The others would be located at the DS maintnenance company.

d. Mechanics Required and Time to Repair

The initialization of these two parameters can be a user-defined parameter. However, specific data can be utilized from the maintenance allocation charts in the technical manuals for particular items of equipment. These charts specifically delineate the approximate manhours required to complete a specific repair. From this data the number of mechanics and the approximate time to repair an item can be determined. An example of a maintenance allocation chart is given in Figure 4.1.

SECTION II. HULL AND RELATED COMPONENTS

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINT. FUNC.	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT.	(6) REMARKS
			C	O	F	H	D		
0	POWERPACK ASSEMBLY	Inspect		0.2				9	
		Test		3.6				1.2.9.12.27	
		Service		6.6				1.9.12	
		Remove/ Install		5.4				1.9.12	K
		Replace		5.4				1.9.12	
		Repair		2.8	11.8			1.3.9.12. 14.15.18	
01	ENGINE								
0120	ENGINE ASSEMBLY	Inspect		0.1	0.1			9	
		Test		1.9				1.27	
		Service	0.2	0.4				9.12	
		Adjust		0.5				27	E
		Replace			6.8			3.9	
		Repair		0.8	3.9		•	1.3.9.12.14. 15.27	
		Overhaul					•		
0121	COMPRESSOR ASSEMBLY, FORWARD ENGINE MODULE	Replace			6.0			3.15.26	
		Repair		0.6			•	9.11	
		Overhaul					•		
	SCREEN ASSEMBLY	Replace		0.2				9	
		Repair			1.0			13.15.25	
	LINER ASSEMBLY, COMBUSTOR	Inspect		0.1				9.11	
		Replace		0.2				9.11	
		Repair					•		
	IGV AND BLEED ACTUATOR	Replace		0.3				9.11	
		Repair		0.2			•	1.9.11.27	D
	VALVE, BUTTERFLY, AIR BLEED	Replace		0.3				1.9.11	
		Repair					•		

Figure 4.1 Maintenance Allocation Chart Example.

C. DESIGN AND DECISION LOGIC DESCRIPTION

The actual design and decision processes utilized in MRM are discussed in the following sections. As stated earlier the MRM is a discrete event time step simulation. This presentation will focus primarily on the tank maintenance and recovery routines but represents the decision logic and processes for all four routines.

At each time step data is input into MRM from ALARM reflecting the total number of vehicles by category that have been assessed as having been hit and damaged during the last time step. At this point MRM takes those vehicles and assesses specific repair requirements based on the empirical probability density functions described in Chapter 3. (see also section 2, appendix A) These repair requirements will be determined for the two forward support maintenance elements and the rear DS company.

1. Initial Queue Allocation Routine (See Figure 4.2)

a. Repair Parts Allocation

Based on the initial input of data, the repair requirements will enter a queue allocation routine. The amount of damage by repair part that has been determined from the probability distribution function is compared with the current stockage of repair parts of that type that are on-hand. If sufficient quantities of parts to satisfy the demand are available, that number of repair jobs go into a waiting repair status and the appropriate number of repair parts are decremented from the on-hand quantity. If there are not enough repair parts to satisfy the demand, the number of jobs that can be repaired with the stocks on-hand go into the waiting repair status. The remainder of the repair jobs enter the waiting parts queue as of that time step. The on-hand stockage of that repair part will then reflect a zero balance.

b. Mechanic Allocation

Upon assignment of those jobs that are in the waiting repair category from above, the number of repair jobs by category is multiplied by the number of mechanics that are required to complete the repair. This will result in the total number of mechanics, by type, that will be required to repair all of the jobs in that waiting repair category. If there are a sufficient number of mechanics available to complete the repairs, those repair jobs enter the under repair queue as of that time. Concurrently a return time queue is initiated which keeps track of time so that when the designated time to repair has passed, the repair jobs that were under repair are completed. The number of mechanics by category that are available for repair will be decremented by the total number of mechanics that were utilized. If there were not enough mechanics to complete the repair work, that percentage of work that can be completed by the mechanics on-hand enter the under repair queue and the remainder enter into a waiting mechanics queue as of that time step. The on-hand number of mechanics available is then set to zero.

c. Running Totals

A running total is maintained which indicates the total number of repair jobs that are either under repair, waiting parts or waiting mechanics. There is also a workload computation done at this point which multiplies those jobs that are waiting mechanics by the manhours that would be required to repair each job. This value is used later in determining if any of the waiting mechanics jobs should be evacuated.

2. <u>Workload Computations</u> (<u>See Figure 4.3</u>)

This routine calculates the maintenance workload at each of the two forward support teams and evacuates any repair work which exceeds their capability to return in a

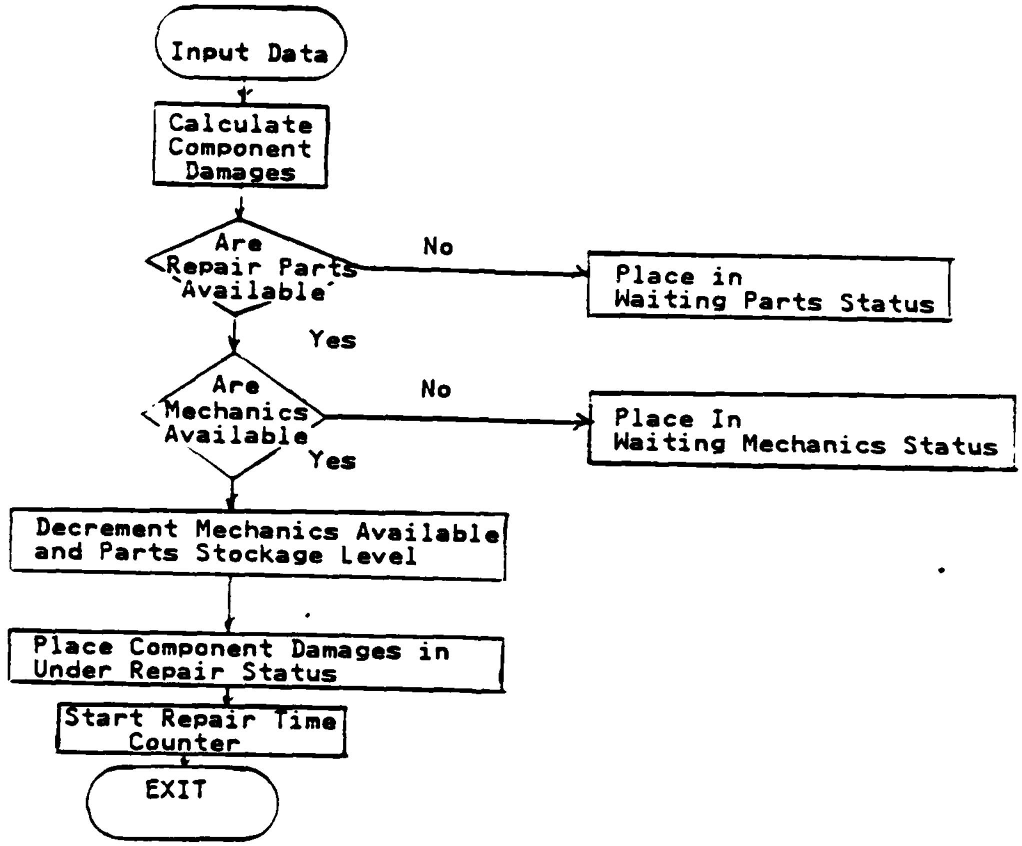


Figure 4.2 Initial Queue Allocation Routine.

designated timeframe. A current workload is calculated for each mechanic type by summing across those repair jobs whose workload indicates that there are repairs waiting mechanics. If the current workload exceeds the allowable workload that was specified in the initialization stage of the model, then those repairs that were waiting mechanics are evacuated to the rear DS maintenance company. The actual evacuation is sequential in that the repairs that require the longest time are evacuated first and the overall workload is recomputed. The order of evacuation for tanks, personnel carriers and howitzers is track, final drives, transfers, transmissions and then engines. Since the armament, electrical and fire control mechanics repair only one component, they will evacuate all repairs that exceed their capability. The order of evacuation for the wheeled vehicles is axle/suspension, transfers, transmissions and then engines.

The actual routine first determines if the current workload exceeds the allowable workload. If it does, then the amount of workload above the allowable is computed and compared against the total track workload of that maintenance element. If the excessive workload is greater than the total track workload, the entire track workload is placed in an evacuation queue as of that time step. The process then repeats for the remaining repair parts until the current workload is less than the allowable workload. If the excessive workload does not exceed the total workload of a particular component then only that portion of the workload above the allowable will be evacuated. Concurrent with the evacuation queue, an evacuation time queue is also established. This time indicates the delay of repair resulting from the in-transit time required for evacuation. Currently this is a user specified input during the initialization phase but will eventually be integrated with the transportation network methodology to determine the time required for evacuation.

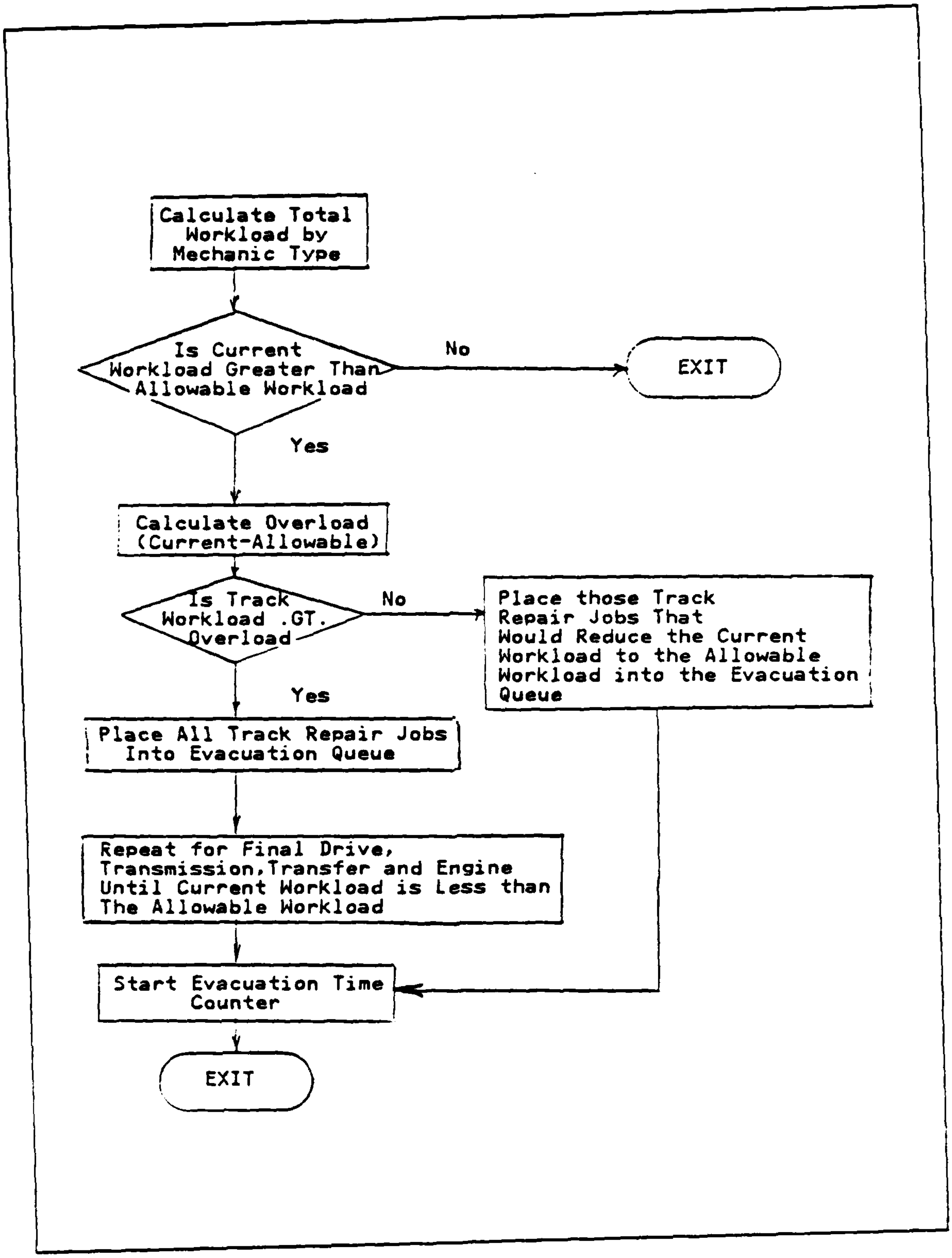


Figure 4.3 Workload Computations.

3. <u>Evacuation Time Routines</u> (<u>See Figure 4.4</u>)

As the model steps through time, jobs that have been evacuated from the forward maintenance support teams will eventually arrive at the DS maintenance company. At each time step the evacuation time routines will loop through all the evacuation times established in the repair evacuation routines. If any of those times are less than or equal to the current time, those evacuated jobs are removed from the evacuation queue and enter into a waiting repair queue at the DS company. These repair jobs then enter the queue allocation routine at the next time step for disposition.

4. <u>Repair and Return Routine</u> (<u>See Figure 4.5</u>)

Each time that a repair job is placed in the under repair queue, a return time queue is initiated to indicate the time when those repairs will be completed. At each time step, the model cycles through these return times to check if any repairs have been completed. If the return time is less than or equal to the current time the jobs will be removed from the under repair queue and will enter into a repaired and returned status as of that time step. At that point the running total for under repair is decremented by the number that have been completed and the number of available mechanics is incremented by that number times the number of mechanics that were required for that repair job. Once this has been completed the model then investigates all the waiting mechanics queues.

5. <u>Waiting Mechanic Routines</u> (<u>See Figure 4.6</u>)

At each time step, the model cycles through the waiting mechanics queues when it has completed the repair and return routines. It cycles through all the queues starting with the oldest waiting mechanics repair jobs and begins assigning the newly returned mechanics from the previous routine. At each time step it determines if there are repairs waiting mechanics, and if so, it determines

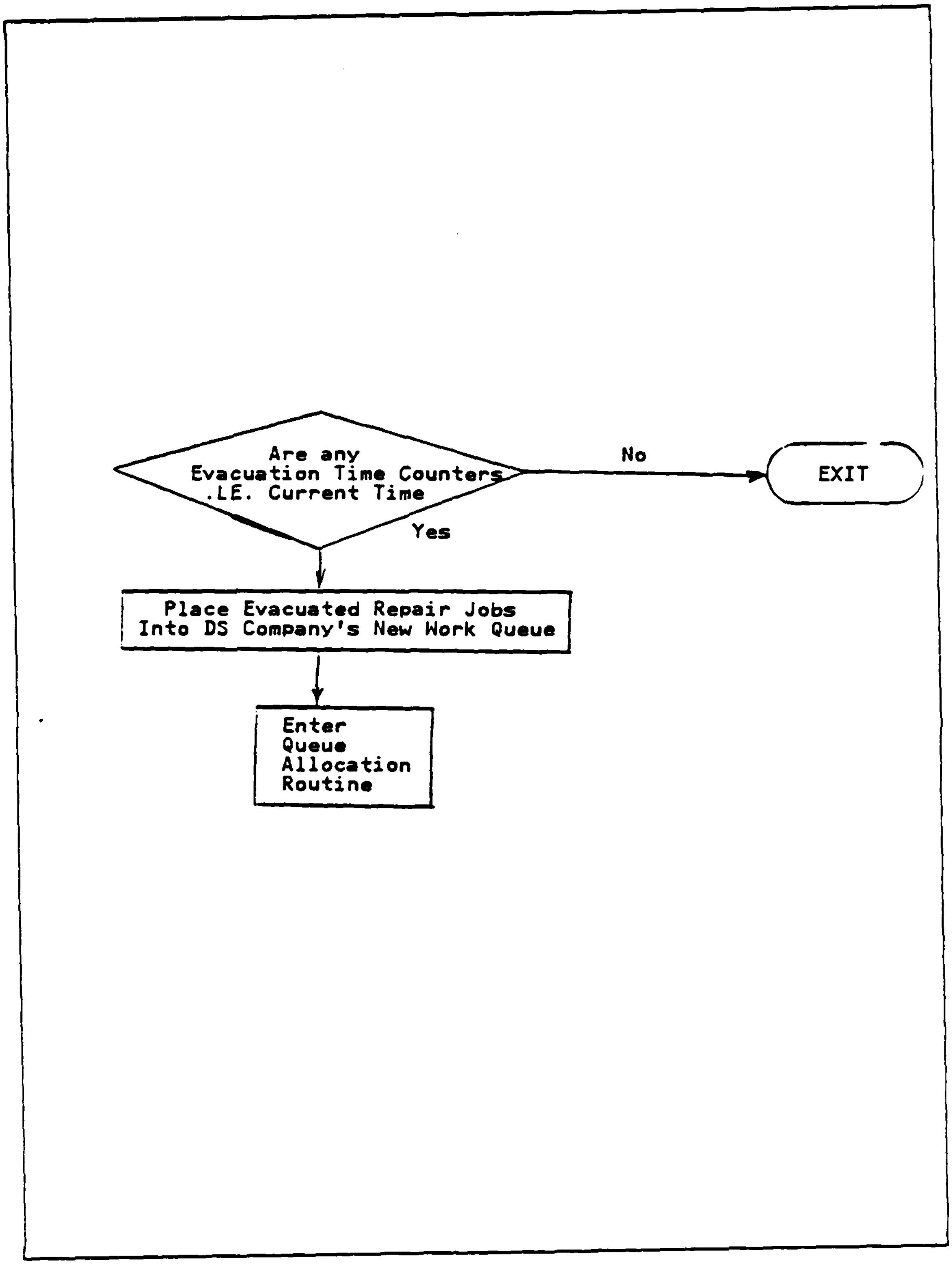


Figure 4.4 Evacuation Time Routine.

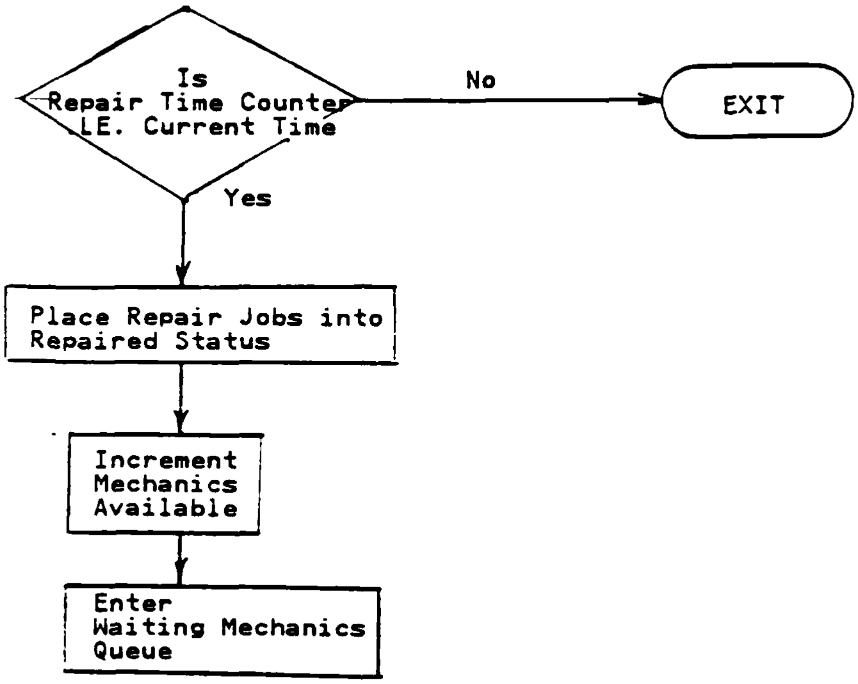


Figure 4.5 Repair Completion Routine.

whether there are mechanics available to do the repairs. If the answer to both is yes, the model then determines the total number of mechanics required to complete the repairs and divides it by the total number of mechanics that are available. If the ratio is less than or equal to one then there are enough mechanics to complete all the repairs in that category that are waiting mechanics. Those repair jobs that were in the waiting mechanics queue are removed and placed in the under repair queue. The total number of mechanics, and the total number of repair jobs waiting mechanics are then decremented. If the ratio is greater than one, then there are not enough mechanics to complete all the repairs, so the number that can be repaired by the mechanics available is removed from the waiting parts queue and placed in the under repair queue. The waiting mechanics queue at that time step is decremented by that same amount and the model then investigates the next mechanic type for available mechanics and repairs waiting mechanics.

6. Output

The final part of the model is the generation of the output. At each time step the output monitors the various queues in the model and presents them in tabular form. From this output repairs can be traced throughout the system. A detailed explanation and analysis of this output is presented in Chapter 5.

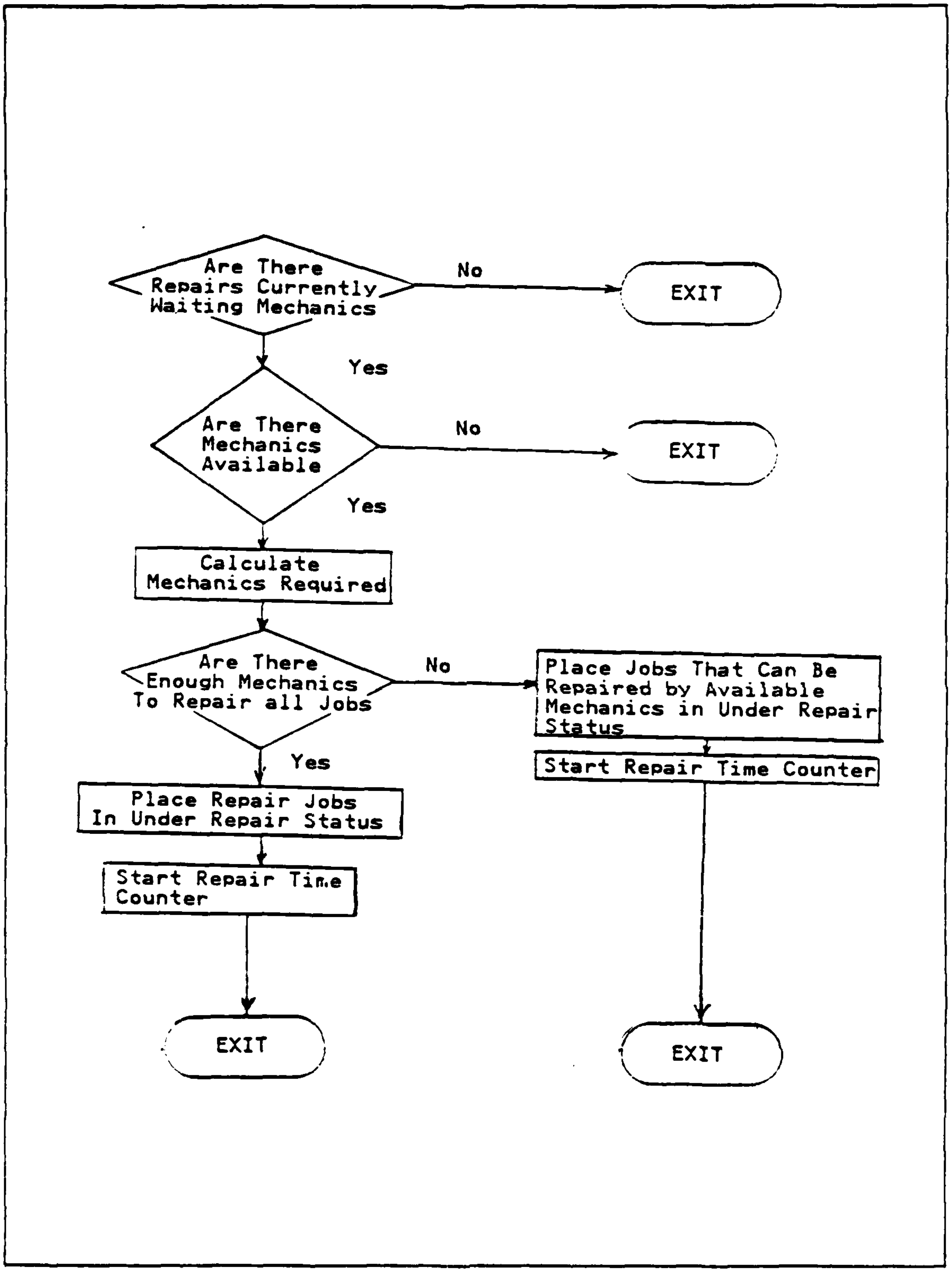


Figure 4.6 Waiting Mechanics Allocation Routine.

V. ANALYSIS OF OUTPUT

A. DISCUSSION OF INITIAL PARAMETERS

This simulation was developed to assist a decision maker in evaluating alternatives with respect to battlefield maintenance and recovery. Specifically this model gives the decision maker the capability to evaluate how battlefield maintenance can affect the combat power of a unit. The model allows a user to reallocate resources among three separate maintenance entities to observe how overall maintenance capability is affected and how this in turn can affect the overall operational readiness of a unit.

Two scenarios are evaluated using the simulation. The first employs the concept of all maintenance being conducted at the DS maintenance company with no fix forward cabability. The second run utilizes the same total numbers of mechanics and repair parts but has two forward support maintenance teams fixing forward. The objective of the analysis is to determine the difference in total number of vehicles repaired and returned over time for these two maintenance concepts. A selected sample of the output generated from these runs is given in Figures 5.1 to 5.12.

B. RECOVER AND REPAIR CONCEPT OF MAINTENANCE

The output for this concept of maintenance is contained in Figures 5.1 to 5.5. Figure 5.1 shows the initial time period of the model. The initial damages were assessed and as can be seen there are no repair jobs under repair at the two forward support maintenance teams. Figure 5.2 shows those damages incurred by the two forward battalions in an evacuated status, and the eventual receipt of the evacuated jobs from the 1st Bn MST by the DS company at time period seven. The evacuation time set for these runs were six hours

from the 1st battalion and four hours from the second battalion. In order to check the accuracy of the algorithms and routines in the model itself, Figures 5.3 to 5.6 were included. From these one can track the change in status over a single time step. Tracking tank engines from time periods 6 to 7 shows that at time period 6 there were 0.95 tanks under repair for engines. In Figure 5.4 we see that the DS company has received no repair jobs for engines from the 1st battalion and 0.70 repair jobs from the 2nd battalion. From the models empirical probability density function we know that tank engines will be damaged with a probability of 0.06353. At time step seven the data input to the model for total tank damages for the DS maintenance company was 17 vehicles. Therefore new engine damages for the DS company at time period seven should equal (17 x 0.06353)+ .00 + 0.70 = 1.78. This is represented under the new damages column in Figure 5.5 for time period seven. This shows that the evacuation routines work correctly and that evacuated equipment from the two forward battalions are being added to the maintenance queues of the DS company.

The under repair columns from these two time periods show that at time six there were 0.95 engines under repair. At time period seven there were a total of 0.06 repairs completed on tank engines. This would then equate to a total of 0.89 engine repair jobs from earlier time periods still under repair. If the 1.78 new damages as listed under the new damages column are added, the new under repair total is 2.67. This is what is indicated at time period seven. (see Figure 5.4)

Figure 5.6 shows the results after the 15th time step, which was the final time step in this simulation and Figure 5.13 shows the final totals of repair jobs completed. This figure will be discussed in more detail after the fix forward concept is presented.

C. FIX FORWARD CONCEPT OF MAINTENANCE

The second run of MRM investigated the fix forward concept of maintenance. The same number of mechanics and repair parts were utilized, however, two maintenance support teams were sent forward with the forward combat battalions. Figures 5.6 to 5.9 show the same time steps as shown for the recover and repair simulation.

Figure 5.6 shows the initial time step of the simulation. As can be seen, all three maintenance elements have repair jobs in the under repair status. Figure 5.7 shows the three elements at time period six. Both forward maintenance units have repair jobs waiting mechanics, but as can be seen from Figure 5.7, the only type of repair job that has exceeded the allowable workload level is the electrical system repairs. The same analysis of time period seven as was done for the recover and repair simulation shows that all the algorithms and routines are functioning correctly. The input stream for this run was identical to the recover and repair simulation. A Check of the new damages to the tank engines in the DS company shows that the only difference between the two runs was the repair jobs that were evacuated from the forward maintenance teams in the recover and repair simulation. Figure 5.10 shows the results of time period seven and Figure 5.11 shows the final time step in the fix forward simulation.

D. OVERALL RESULTS OF THE TWO SIMULATIONS

The major objective of the analysis was to determine if there is any difference in the relative maintenance effectiveness of these two different concepts of maintenance support. Figure 5.12 shows the total repairs completed by each concept as of the final time step. Summing the total repair jobs across all the components gives a total of 73.42 tanks under the recover and repair concept and 105.11 tanks under the fix forward concept.

Analysis of the data was done to investigate these results. Figures 5.12 to 5.13 show the total results from these two runs in the categories of total repairs completed, mechanics remaining at each time step, and the number of tanks waiting mechanics at each time step. Figures 5.14 to 5.17 show a breakout of the mechanic categories by mechanic type. Each of these Figures show a significant change at time period seven. Analysis of the data input for this time period indicated that there was a large influx of damaged equipment at that point.

Figure 5.10 shows the repair totals in each of the two runs over the fifteen time steps. The first repairs are completed at time period three. From time periods three through eight, the slope of the total repair curve is greater for the fix forward concept than for the recover and repair concept. This indicates a repair lag resulting from the evacuation time lag. At time period eight this initial lag has been overcome and the slope of the total repair curves for both concepts are approximately equal. This result was surprising. The a priori postulate was that as the evacuation lag was overcome the repair total for the recover and repair concept would be greater than the fix forward concept because of increased economies of scale. With the consolidation of all the mechanics in one element it was felt that total repair rate would increase. The model results indicated that this is not neccessarily the case. Although the evacuation lag was overcome, the difference in total repairs for each concept remained essentially constant. With the total number of mechanics being equal in both runs the number of tanks which can be put in an under repair status has an upper limit. This limit is attained when all available mechanics are repairing vehicles. Regardless of where the mechanics are located they cannot repair and return vehicles at any faster rate. If this

saturation is realized then there will be little difference in the repair rates of the two concepts.

Figures 5.18 and 5.19 give the total number of tanks under repair and in an evacuated status. The evacuated totals for the recover and repair concept are much larger than for the fix forward concept as expected. The difference between these curves is the total number of tanks that are unavailable for repair because they are in transit between the forward and rear elements. In contrasting the waiting mechanics graph (Figure 5.13) and the evacuation graph (Figure 5.19) we can see the tradeoff between the two maintenance concepts. As an example, at time period 7 the number of tanks waiting mechanics is approximately 48 for the fix forward concept. For the recover and repair concept the number of tanks evacuated at this same time step is approximately 55 more than the fix forward concept. This indicates that these tanks are going to be placed in one of two queues; either evacuated or waiting mechanics. In the recover and repair concept evacuation time is uncontrolled. It depends on the relative position of the maintenance elements and the combat elements on the battlefield. In the fix forward concept the number of mechanics in each forward element can be changed which could result in a lessening of the waiting mechanics queues in them. As a result MRM can assist us in deciding on an optimal mix of assets between the forward elements and the rear DS company.

Figures 5.11 through 5.17 show the total mechanics remaining at each time step, the total tanks waiting mechanics at each time step and a breakout of each of these categories by mechanic type.

Figure 5.12 shows the mechanics remaining at each time step. From this Figure we can see that, initially, the recover and repair concept has a lot of mechanics not being utilized. It is not until the evacuation lag has been

overcome that the difference between mechanics remaining under the two concepts decreases. When this Figure and the total repair Figure are compared, it indicates that the fix forward concept of repair tends to provide a more efficient initial utilization of mechanics.

Figure 5.13 shows the number of tanks that are waiting mechanics at each time step. This Figure indicates that the relative number of vehicles waiting mechanics is greater for the fix forward concept. This is a result caused by the relative size of the fix forward teams. It can be seen from the Figure that the recover and repair concept has an increase in jobs waiting mechanics beginning at time period 11 which results from the evacuation lag. At time period seven, when there was a significant increase in damaged vehicles, there were many vehicles placed in a waiting mechanics status in the forward elements. Those repairs jobs in the recover and repair concept were all evacuated and arrived at the rear DS company between time periods eleven and thirteen. Due to the greater number of mechanics consolidated in one element in the recover and repair concept, the relative magnitude of the waiting mechanics queue was smaller.

Figures 5.14 to 5.17 show a breakout by mechanic type for the two categories discussed above. These were included to show that although the graphs show mechanics remaining, those mechanics cannot repair all damages. Specific shortages which drove the total waiting mechanics Figure were in all categories in the fix forward concept and in the electrical mechanic in the recover and repair concept. This would indicate that either an increase in the numbers of these mechanics is required or a different mix of fix forward assets and rear area assets is needed.

E. SUMMARY

Chapters 4 and 5 have focused on the tank routine as an example. There are however four separate, interrelated routines that also deal with the armored personnel carriers, artillery pieces and wheeled vehicles. The tank routines were the only ones shown in this thesis for brevity. The other routines are identical except for the empirical probability density functions discussed in chapter three.

Overall MRM has provided information and data relative to the two maintenance concepts being investigated. It provides the user with the ability to assess the final results of a maintenance concept in order to help him decide which concept to use. Upon final integration with the Airland Research Model this maintenance module will provide a realistic simulation of the repair and return of damaged combat vehicles in any scenario.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 1.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.64	0.00	0.00	0.00	0.00	99.36
XMN	0.87	0.00	0.00	0.00	0.00	59.13
XFR	0.59	0.00	0.00	0.00	0.00	29.41
TRK	3.20	0.00	0.00	0.00	0.00	56.80
FCN	0.87	0.00	0.00	0.00	0.00	29.13
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.04	0.00	0.00	0.00	0.00	28.96
ELE	1.15	0.00	0.00	0.00	0.00	18.85

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 1.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.51	0.00	0.00	0.00	0.00	99.49
XMN	0.70	0.00	0.00	0.00	0.00	59.30
XFR	0.47	0.00	0.00	0.00	0.00	29.53
TRK	2.56	0.00	0.00	0.00	0.00	57.44
FCN	0.70	0.00	0.00	0.00	0.00	29.30
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.83	0.00	0.00	0.00	0.00	29.17
ELE	0.92	0.00	0.00	0.00	0.00	19.08

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 1.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.95	0.95	0.00	0.00	0.00	99.05
XMN	1.31	1.31	0.00	0.00	0.00	58.69
XFR	0.87	0.87	0.00	0.00	0.00	29.13
TRK	4.80	4.80	0.00	0.00	0.00	75.20
FCN	1.31	1.31	0.00	0.00	0.00	28.69
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.55	1.55	0.00	0.00	0.00	28.45
ELE	1.73	1.73	0.00	0.00	0.00	18.27

Figure 5.1 Recover and Repair Time Step 1.

TIME= 1.00 HRS

	EVACUATED FROM 1ST BN (EN ROUTE)	EVACUATED FROM 2ND BN (EN ROUTE)	RECEIVED BY DS FROM 1ST BN AT THIS TIME	RECEIVED BY DS FROM 2ND BN AT THIS TIME
ENG	0.64	0.51	0.00	0.00
XMN	0.87	0.70	0.00	0.00
XFR	0.59	0.47	0.00	0.00
FDR	0.00	0.00	0.00	0.00
TRK	3.20	2.56	0.00	0.00
FCN	0.87	0.70	0.00	0.00
ARM	1.04	0.83	0.00	0.00
ELE	1.15	0.92	0.00	0.00

TIME= 7.00 HRS

	EVACUATED FROM 1ST BN (EN ROUTE)	EVACUATED FROM 2ND BN (EN ROUTE)	RECEIVED BY DS FROM 1ST BN AT THIS TIME	RECEIVED BY DS FROM 2ND BN AT THIS TIME
ENG	3.56	2.35	0.64	0.13
XMN	4.88	3.22	0.87	0.17
XFR	3.29	2.18	0.59	0.12
FDR	0.00	0.00	0.00	0.00
TRK	17.92	11.84	3.20	0.64
FCN	4.88	3.22	0.87	0.17
ARM	5.80	3.83	1.04	0.21
ELE	6.46	4.27	1.15	0.23

Figure 5.2 Recover and Repair Evacuation Example.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 6.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.57	0.00	0.00	0.00	0.00	98.09
XMN	0.78	0.00	0.00	0.00	0.00	57.39
XFR	0.53	0.00	0.00	0.00	0.00	28.24
TRK	2.88	0.00	0.00	0.00	0.00	50.40
FCN	0.78	0.00	0.00	0.00	0.00	27.39
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.93	0.00	0.00	0.00	0.00	26.89
ELE	1.04	0.00	0.00	0.00	0.00	16.54

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 6.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.44	0.00	0.00	0.00	0.00	97.97
XMN	0.61	0.00	0.00	0.00	0.00	57.21
XFR	0.41	0.00	0.00	0.00	0.00	28.12
TRK	2.24	0.00	0.00	0.00	0.00	49.76
FCN	0.61	0.00	0.00	0.00	0.00	27.21
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.72	0.00	0.00	0.00	0.00	26.69
ELE	0.81	0.00	0.00	0.00	0.00	16.31

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 6.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.76	0.95	0.00	0.00	0.19	97.33
XMN	1.04	1.31	0.00	0.00	0.26	56.34
XFR	0.70	0.88	0.00	0.00	0.17	27.55
TRK	3.84	13.44	0.00	0.00	0.00	66.56
FCN	1.04	1.31	0.00	0.00	0.26	26.34
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.24	2.80	0.00	0.00	1.55	25.65
ELE	1.38	4.84	0.00	0.00	0.00	15.16

Figure 5.3 Recover and Repair Time Step 6.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 7.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	2.29	0.00	0.00	0.00	0.00	95.81
XMN	3.13	0.00	0.00	0.00	0.00	54.25
XFR	2.12	0.00	0.00	0.00	0.00	26.12
TRK	11.52	0.00	0.00	0.00	0.00	38.88
FCN	3.13	0.00	0.00	0.00	0.00	24.25
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	3.73	0.00	0.00	0.00	0.00	23.17
ELE	4.15	0.00	0.00	0.00	0.00	12.39

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 7.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	1.65	0.00	0.00	0.00	0.00	96.32
XMN	2.26	0.00	0.00	0.00	0.00	54.95
XFR	1.53	0.00	0.00	0.00	0.00	26.59
TRK	8.32	0.00	0.00	0.00	0.00	41.44
FCN	2.26	0.00	0.00	0.00	0.00	24.95
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	2.69	0.00	0.00	0.00	0.00	24.00
ELE	3.00	0.00	0.00	0.00	0.00	13.31

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 7.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	1.78	2.67	0.00	0.00	0.06	95.55
XMN	2.44	3.66	0.00	0.00	0.09	53.91
XFR	1.64	2.46	0.00	0.00	0.06	25.91
TRK	8.96	22.40	0.00	0.00	0.00	57.60
FCN	2.44	3.66	0.00	0.00	0.09	23.91
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	2.90	4.76	0.00	0.00	0.93	22.75
ELE	3.23	8.07	0.00	0.00	0.00	11.93

Figure 5.4 Recover and Repair Time Step 7.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 15.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.70	0.00	0.00	0.00	0.00	93.46
XMN	0.96	0.00	0.00	0.00	0.00	51.03
XFR	0.65	0.00	0.00	0.00	0.00	23.94
TRK	3.52	0.00	0.00	0.00	0.00	27.04
FCN	0.96	0.00	0.00	0.00	0.00	21.03
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.14	0.00	0.00	0.00	0.00	19.34
ELE	1.27	0.00	0.00	0.00	0.00	8.13

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 15.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.70	0.00	0.00	0.00	0.00	94.16
XMN	0.96	0.00	0.00	0.00	0.00	51.99
XFR	0.65	0.00	0.00	0.00	0.00	24.59
TRK	3.52	0.00	0.00	0.00	0.00	30.56
FCN	0.96	0.00	0.00	0.00	0.00	21.99
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.14	0.00	0.00	0.00	0.00	20.48
ELE	1.27	0.00	0.00	0.00	0.00	9.39

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 15.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	1.65	4.07	0.00	1.65	2.03	84.56
XMN	2.26	5.57	0.00	2.26	2.79	38.84
XFR	1.52	3.76	0.00	1.52	1.88	15.75
TRK	8.32	58.24	0.00	10.87	0.96	2.24
FCN	2.26	7.84	0.00	0.00	2.79	8.84
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	2.69	13.77	0.00	0.00	0.31	4.84
ELE	3.00	10.00	8.02	1.93	3.23	0.00

Figure 5.5 Recover and Repair Final Time Step (15).

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 1.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.64	0.64	0.00	0.00	0.00	99.36
XMN	0.87	0.87	0.00	0.00	0.00	59.13
XFR	0.59	0.59	0.00	0.00	0.00	29.41
TRK	3.20	3.20	0.00	0.00	0.00	56.80
FCN	0.87	0.87	0.00	0.00	0.00	29.13
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.04	1.04	0.00	0.00	0.00	28.96
ELE	1.15	1.15	0.00	0.00	0.00	18.85

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 1.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.51	0.51	0.00	0.00	0.00	99.49
XMN	0.70	0.70	0.00	0.00	0.00	59.30
XFR	0.47	0.47	0.00	0.00	0.00	29.53
TRK	2.56	2.56	0.00	0.00	0.00	57.44
FCN	0.70	0.70	0.00	0.00	0.00	29.30
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.83	0.83	0.00	0.00	0.00	29.17
ELE	0.92	0.92	0.00	0.00	0.00	19.08

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 1.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.95	0.95	0.00	0.00	0.00	99.05
XMN	1.31	1.31	0.00	0.00	0.00	58.69
XFR	0.87	0.87	0.00	0.00	0.00	29.13
TRK	4.80	4.80	0.00	0.00	0.00	75.20
FCN	1.31	1.31	0.00	0.00	0.00	28.69
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.55	1.55	0.00	0.00	0.00	28.45
ELE	1.73	1.73	0.00	0.00	0.00	18.27

Figure 5.6 Fix Forward Time Step 1.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 6.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.57	0.89	0.00	0.00	0.06	98.09
XMN	0.78	1.22	0.00	0.00	0.09	57.39
XFR	0.53	0.82	0.00	0.00	0.06	28.24
TRK	2.88	9.60	0.00	0.00	0.00	50.40
FCN	0.78	1.22	0.00	0.00	0.09	27.39
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.93	2.07	0.00	0.00	1.04	26.89
ELE	1.04	2.50	0.00	0.96	0.00	16.54

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 6.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.44	0.70	0.00	0.00	0.13	97.97
XMN	0.61	0.96	0.00	0.00	0.17	57.21
XFR	0.41	0.65	0.00	0.00	0.12	28.12
TRK	2.24	10.24	0.00	0.00	0.00	49.76
FCN	0.61	1.29	0.00	0.00	0.00	27.21
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.72	2.48	0.00	0.00	0.83	26.69
ELE	0.81	2.50	0.00	1.19	0.00	16.31

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 6.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.25	0.44	0.00	0.00	0.19	97.84
XMN	0.35	0.61	0.00	0.00	0.26	57.04
XFR	0.23	0.41	0.00	0.00	0.17	28.02
TRK	1.28	10.88	0.00	0.00	0.00	69.12
FCN	0.35	0.61	0.00	0.00	0.26	27.04
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	0.41	1.97	0.00	0.00	1.55	26.48
ELE	0.46	3.92	0.00	0.00	0.00	16.08

Figure 5.7 Fix Forward Time Step 6.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 7.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	2.29	2.08	0.00	0.97	0.13	95.81
XMN	3.13	1.04	0.00	3.13	0.17	54.25
XFR	2.12	0.71	0.00	2.12	0.12	26.12
TRK	11.52	9.60	0.00	3.62	0.00	38.88
FCN	3.13	1.50	0.00	2.40	0.17	24.25
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	3.73	2.50	0.00	2.22	0.52	23.17
ELE	4.15	2.50	0.00	1.25	0.00	12.39

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 7.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	1.65	2.16	0.00	0.00	0.19	96.32
XMN	2.26	0.85	0.00	2.11	0.26	54.95
XFR	1.53	0.47	0.00	1.53	0.18	26.59
TRK	8.32	10.24	0.00	4.18	0.00	41.44
FCN	2.26	1.50	0.00	1.46	0.59	24.95
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	2.69	2.50	0.00	1.54	1.14	24.00
ELE	3.00	2.50	0.00	1.25	0.00	13.31

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 7.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	1.08	1.46	0.00	0.00	0.06	96.76
XMN	1.48	2.00	0.00	0.00	0.09	55.56
XFR	0.99	1.34	0.00	0.00	0.06	27.03
TRK	5.44	16.32	0.00	0.00	0.00	63.68
FCN	1.48	2.00	0.00	0.00	0.09	25.56
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.76	2.80	0.00	0.00	0.93	24.72
ELE	1.96	5.00	0.00	0.88	0.00	14.12

Figure 5.8 Fix Forward Time Step 7.

1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF 15.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.70	0.00	0.00	2.35	0.00	93.46
XMN	0.96	0.00	0.00	3.22	0.95	51.03
XFR	0.65	1.44	0.00	2.18	0.68	23.94
TRK	3.52	13.56	0.00	0.44	0.32	27.04
FCN	0.96	1.50	0.00	0.79	0.78	21.03
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.14	2.50	0.00	1.79	0.31	19.34
ELE	1.27	2.50	0.00	1.25	0.00	8.13

2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF 15.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.70	0.57	0.00	1.59	0.00	94.16
XMN	0.96	0.78	0.00	2.18	0.07	51.99
XFR	0.65	0.53	0.00	1.47	1.53	24.59
TRK	3.52	11.94	0.00	3.42	0.64	30.56
FCN	0.96	1.50	0.00	0.72	0.61	21.99
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	1.14	2.50	0.00	1.79	0.02	20.48
ELE	1.27	2.50	0.00	1.25	0.00	9.39

DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF 15.00 HRS

SYSTEM	NEW DAMAGES	UNDER REPAIR	WAITING PARTS	WAITING MECHANICS	REPAIRS COMPLETED	PARTS ON HAND
ENG	0.70	1.21	0.00	0.00	0.19	94.09
XMN	0.96	1.65	0.00	0.00	0.26	51.90
XFR	0.64	1.11	0.00	0.00	0.17	24.58
TRK	8.64	42.08	0.00	0.00	0.96	29.28
FCN	1.74	2.72	0.00	0.00	0.26	20.84
FDR	0.00	0.00	0.00	0.00	0.00	50.00
ARM	2.47	4.41	0.00	0.00	0.10	18.44
ELE	2.65	5.00	0.00	9.94	1.08	0.06

Figure 5.9 Fix Forward Final Time Step (15).

TIME= 15.00 HRS

TOTAL REPAIRS COMPLETED AS OF THIS TIME BY EACH MAINTENANCE ELEMENT

SYSTEM	1ST BN MST	2ND BN MST	DS MAINT CO
ENG	0.00	0.00	9.72
XMN	0.00	0.00	13.32
XFR	0.00	0.00	8.96
FDR	0.00	0.00	0.00
TRK	0.00	0.00	8.64
FCN	0.00	0.00	13.32
ARM	0.00	0.00	11.39
ELE	0.00	0.00	8.07

TIME= 15.00 HRS

TOTAL REPAIRS COMPLETED AS OF THIS TIME BY EACH MAINTENANCE ELEMENT

SYSTEM	1ST BN MST	2ND BN MST	DS MAINT CO
ENG	4.19	3.68	4.70
XMN	5.75	5.05	6.44
XFR	2.44	3.41	4.32
FDR	0.00	0.00	0.00
TRK	5.12	6.72	8.64
FCN	5.61	5.79	6.44
ARM	4.67	5.00	7.14
ELE	2.50	2.50	5.00

Figure 5.10 Final Totals of Both Concepts.

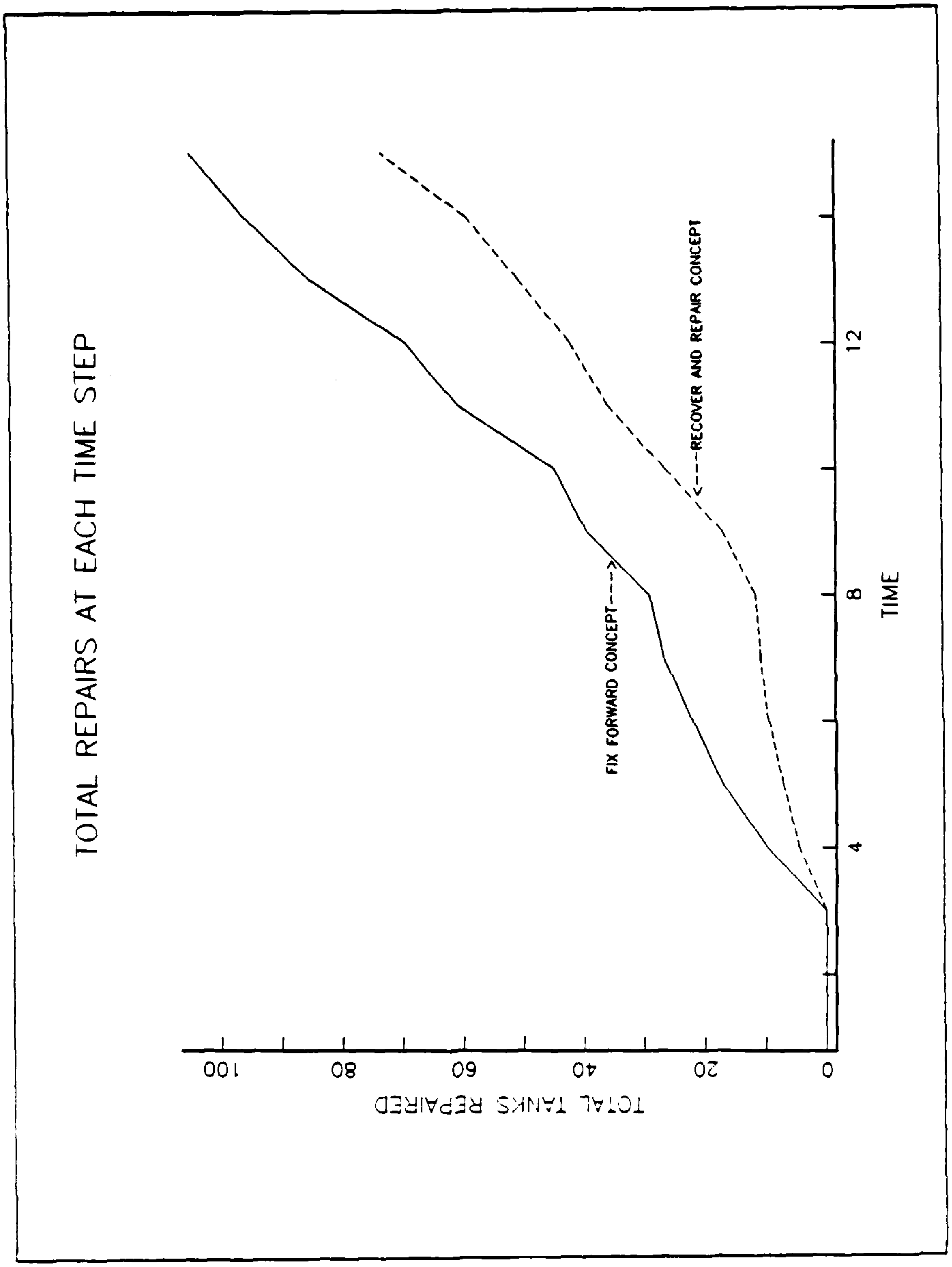


Figure 5.11 Total Repairs.

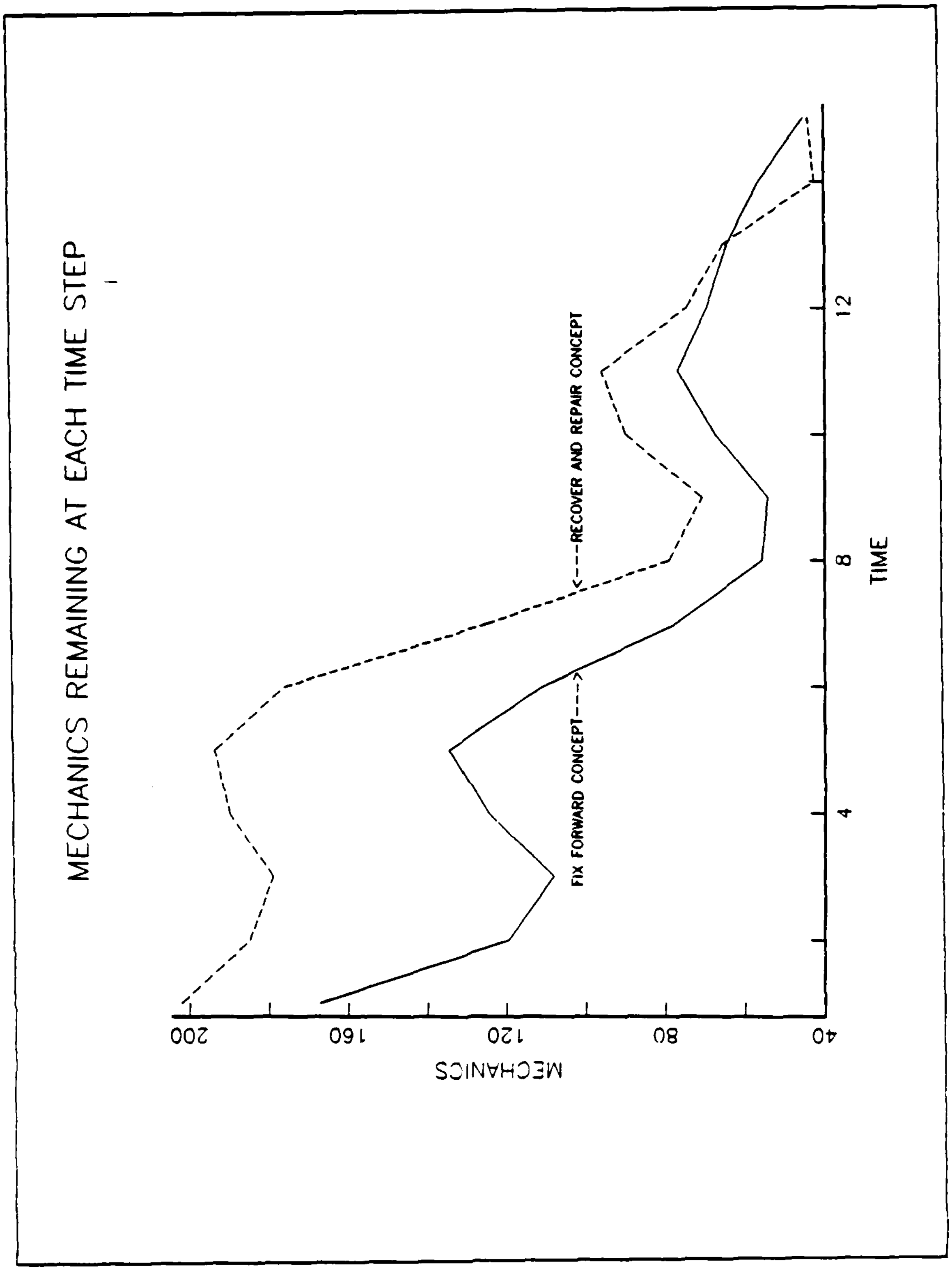


Figure 5.12 Total Mechanics Remaining.

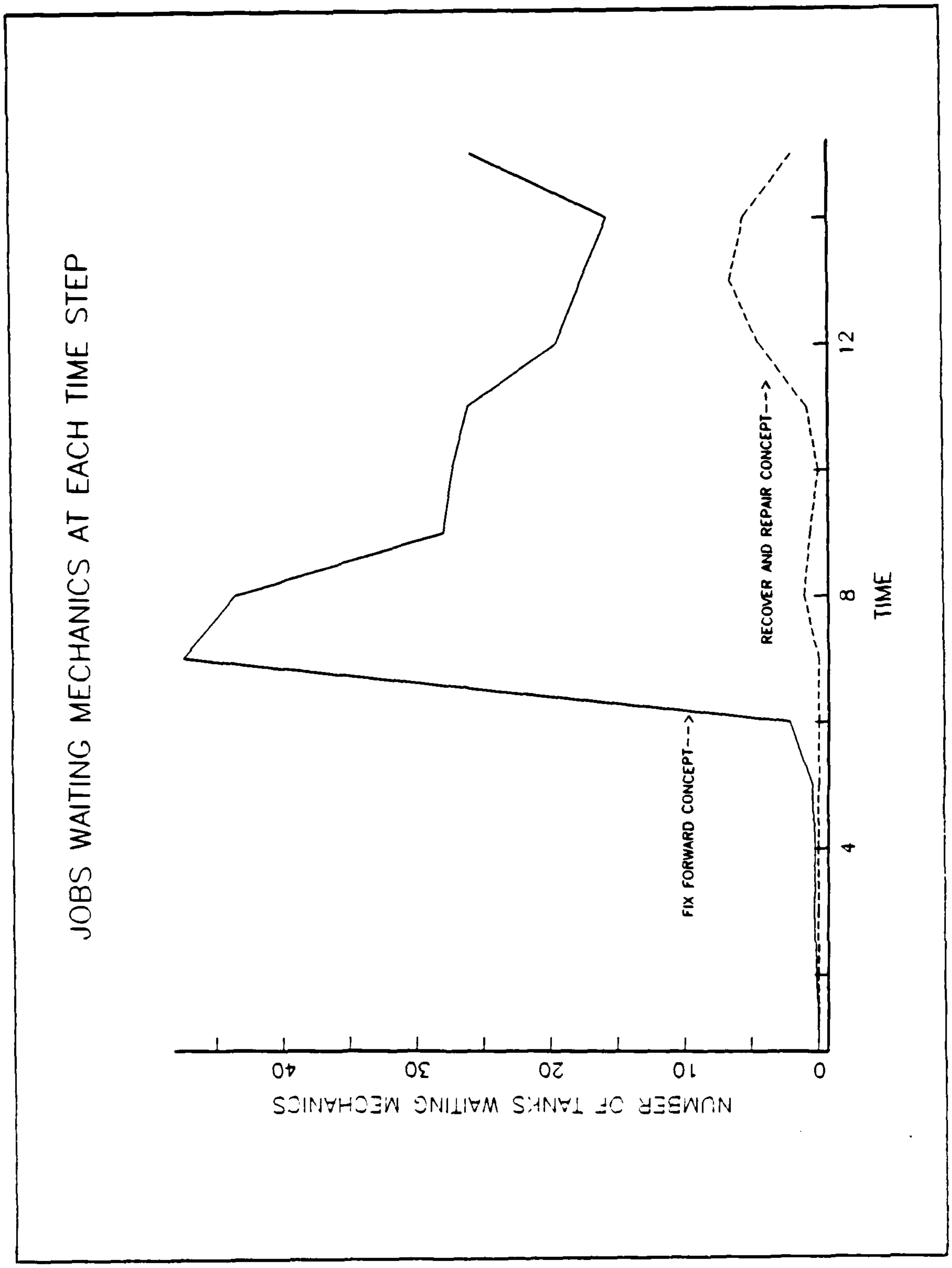


Figure 5.13 Total Waiting Mechanics.

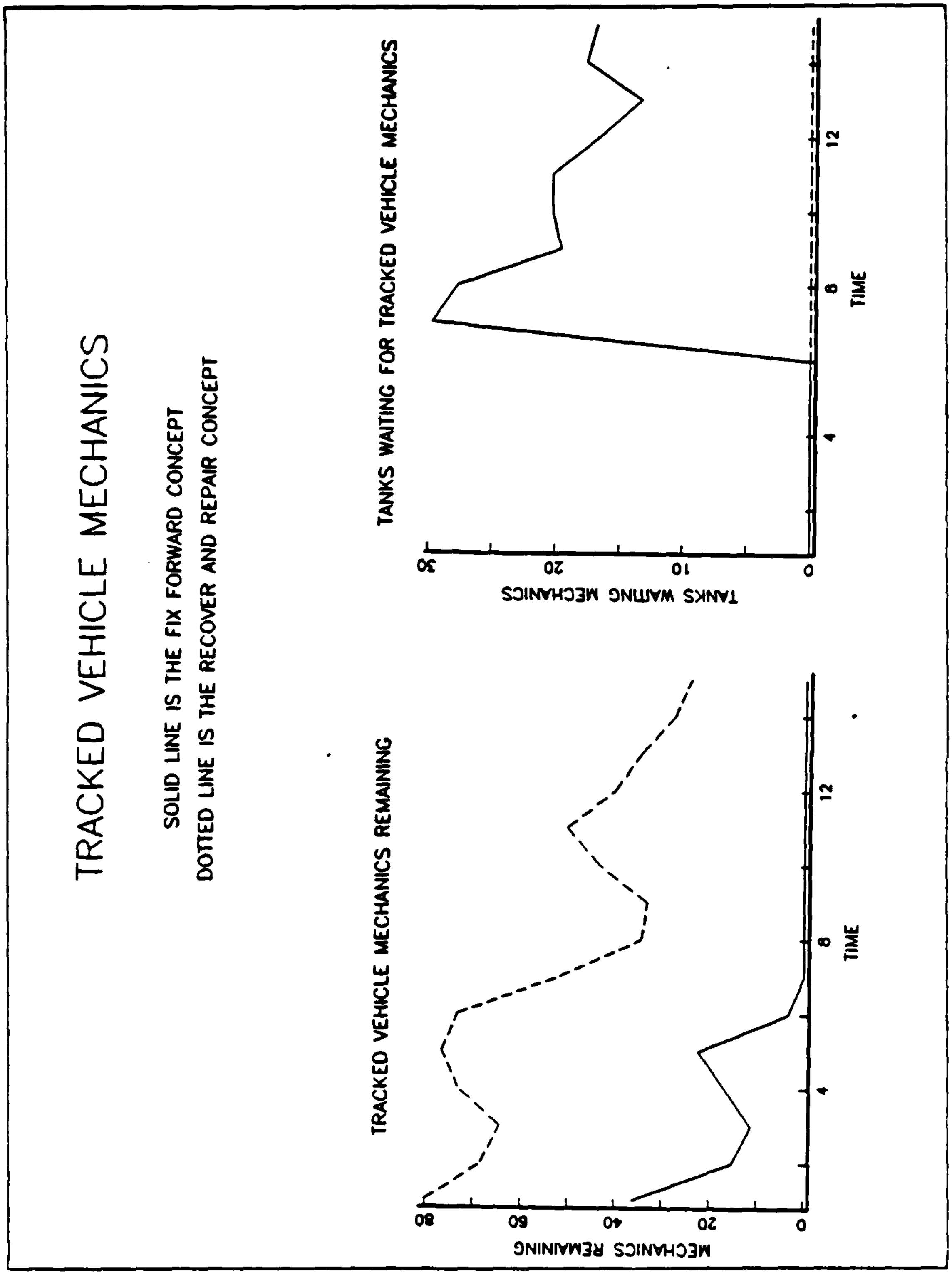


Figure 5.14 Tracked Vehicle Mechanics.

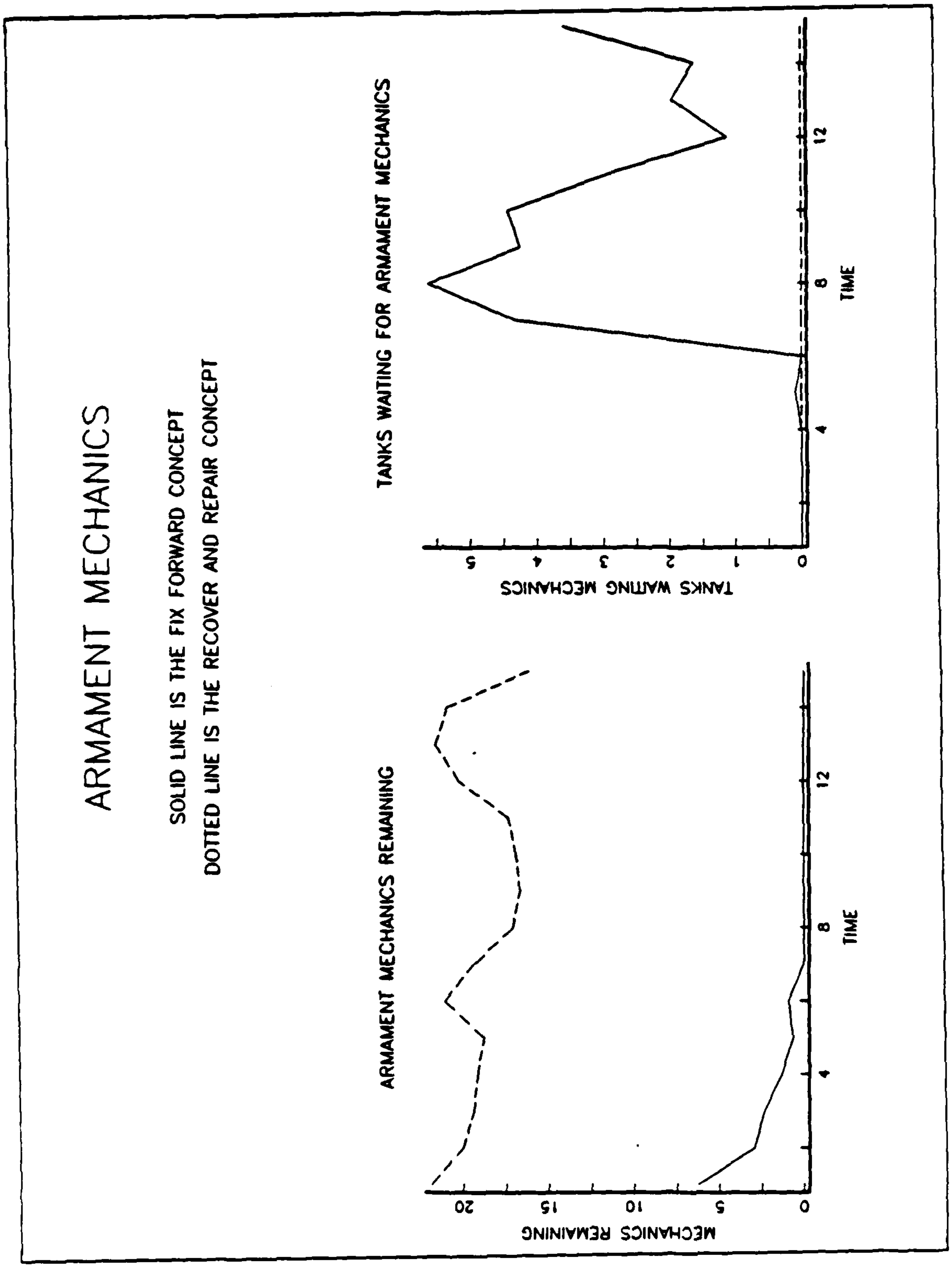


Figure 5.15 Armament Mechanics.

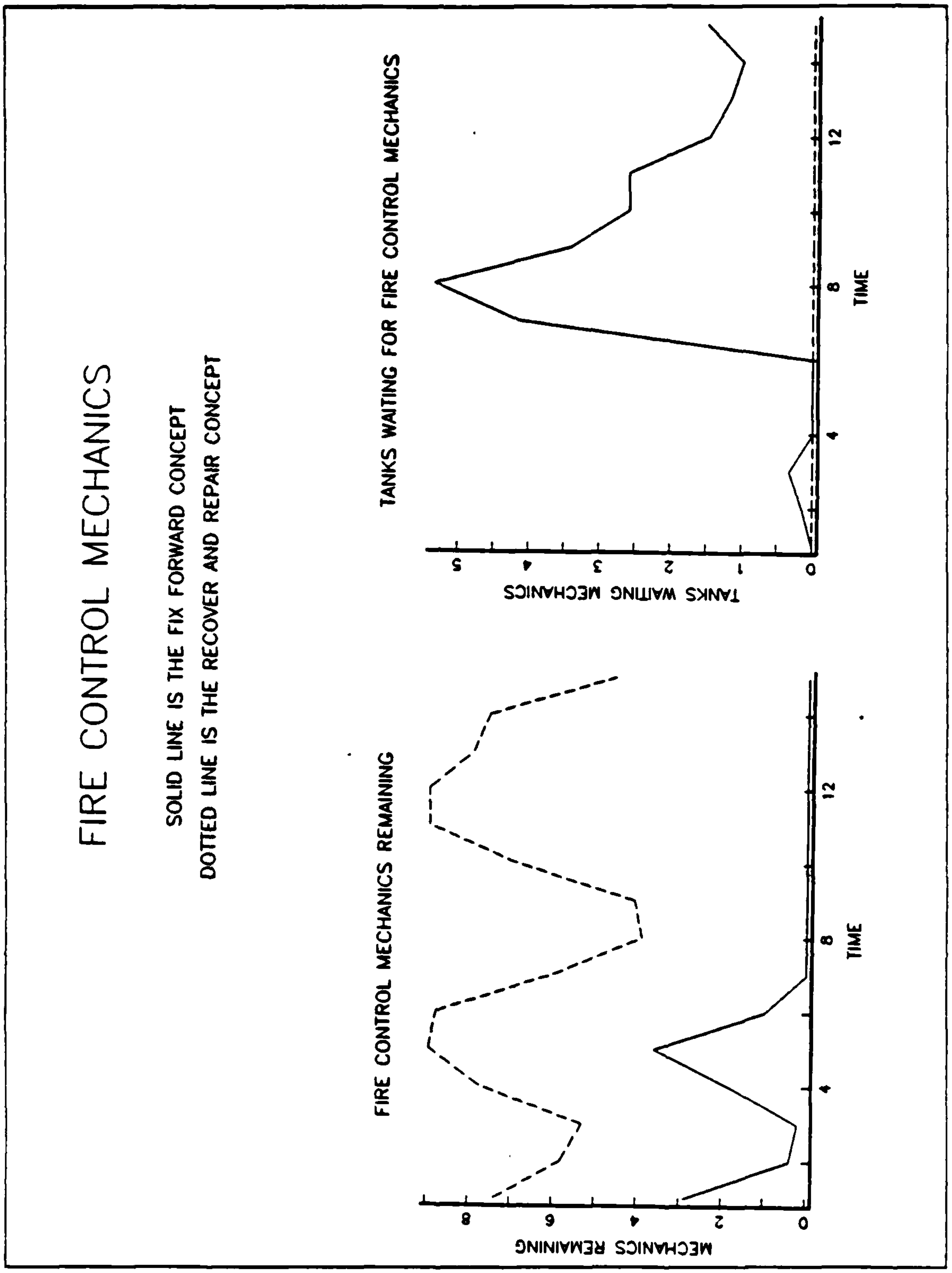


Figure 5.16 Fire Control Mechanics.

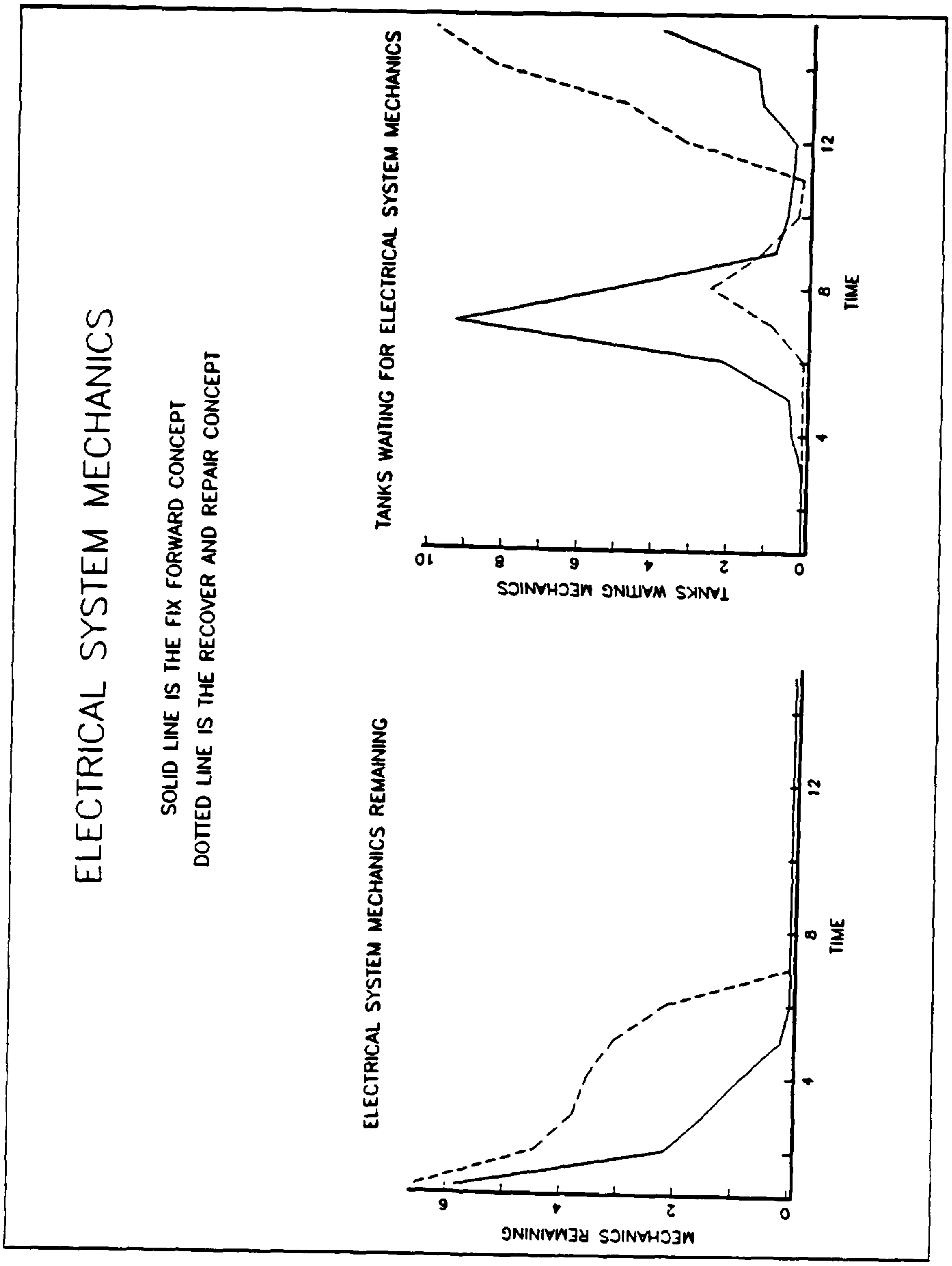


Figure 5.17 Electrical Mechanics.

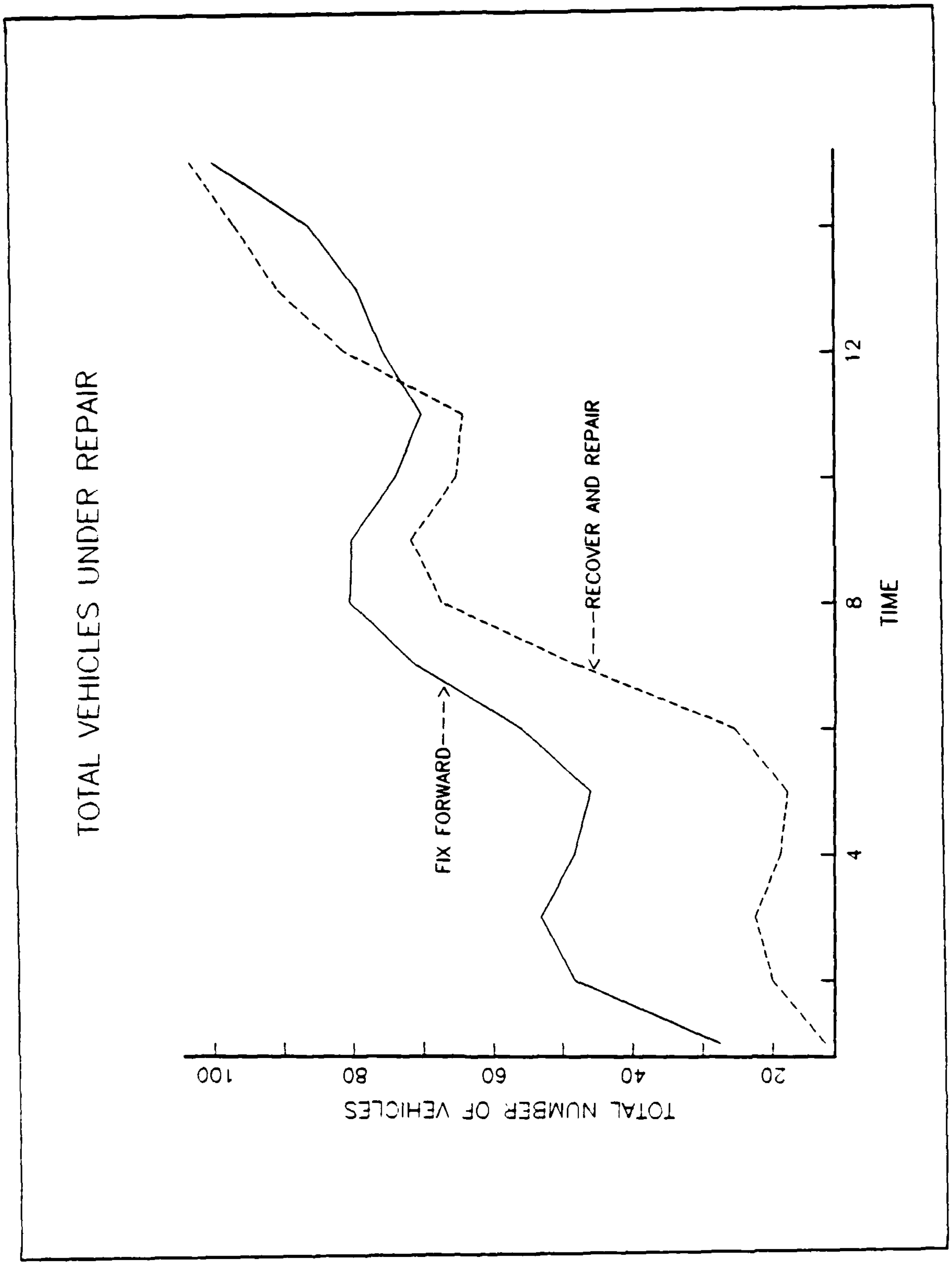


Figure 5.18 Total Vehicles Under Repair.

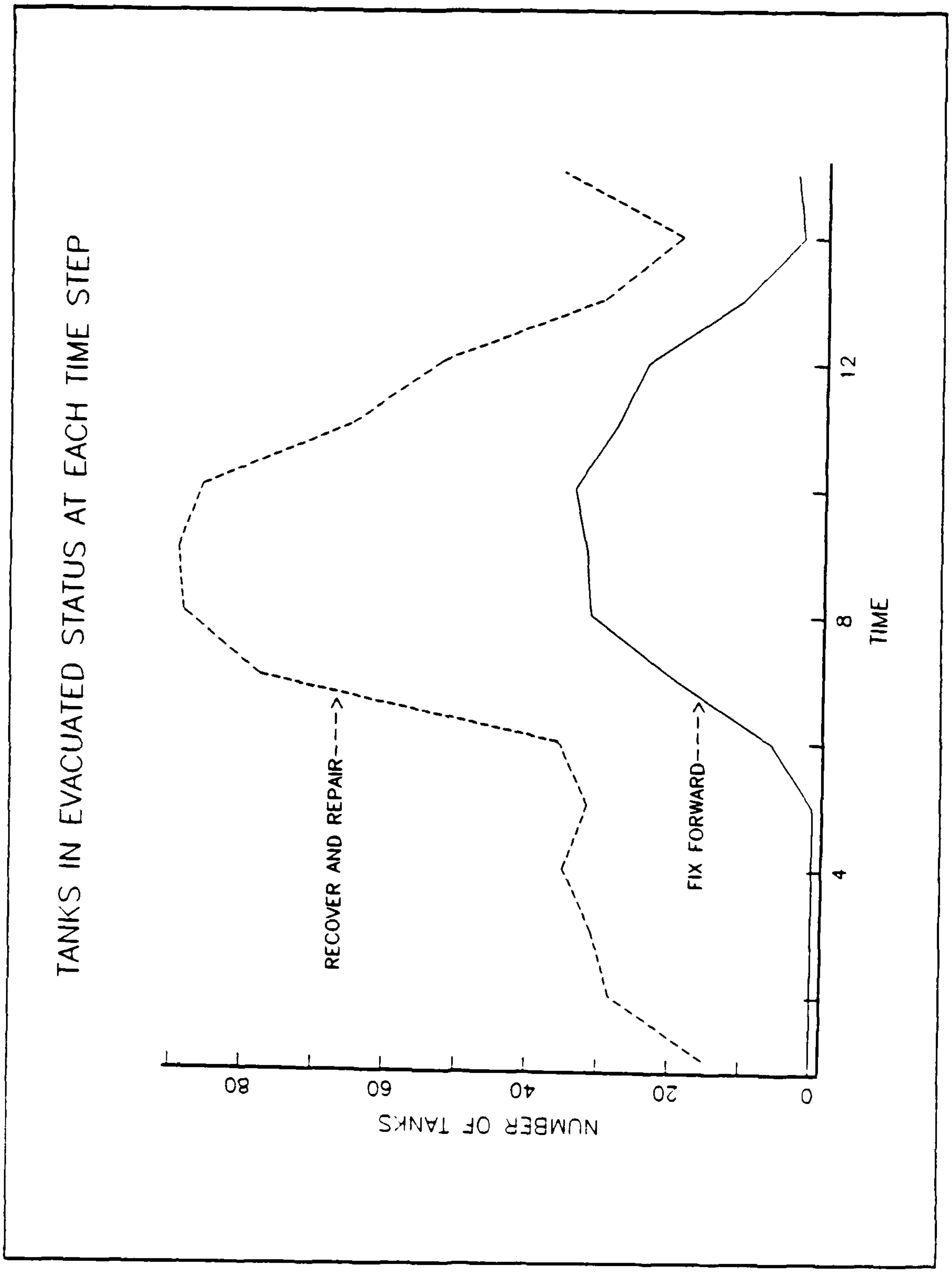


Figure 5.19   Total Vehicles in an Evacuated Status.

APPENDIX A

TANK PROGRAM LISTING

1. INITIALIZATION

The majority of this section has been deleted from this appendix for brevity. This section initialized and defined all the variables and queues that were utilized in this simulation

```
THESE ARE THE NUMBER OF VEHICLES BY TYPE IN AN ARMORED BRIGADE.

TANKS=162.0

THESE ARE THE INITIAL ON HAND QUANTITES OF REPAIR PARTS AND THE
CALCULATION OF THE REORDER POINTS.

TENG3=100.0
TENG1=40.0
TENG2=40.0
TENGRP=(TENG3+TENG1+TENG2)*0.3
TXMN3=60.0
TXMN1=30.0
TXMN2=30.0
TXMNRP=(TXMN3+TXMN1+TXMN2)*0.3
TXFR3=30.0
TXFR1=20.0
TXFR2=20.0
TXFRRP=(TXFR3+TXFR1+TXFR2)*0.3
TFDR3=50.0
TFDR1=20.0
TFDR2=20.0
TFDRRP=(TFDR3+TFDR1+TFDR2)*0.3
TFCN3=30.0
TFCN1=20.0
TFCN2=20.0
TFCNRP=(TFCN3+TFCN1+TFCN2)*0.3
TARM3=30.0
TARM1=20.0
TARM2=20.0
```

```
TARMRP=(TARM3+TARM1+TARM2)*0.3
TELE3=20.0
TELE1=10.0
TELE2=10.0
TELERP=(TELE3+TELE1+TELE2)*0.3
TTRK3=40.0
TTRK1=20.0
TTRK2=20.0
TTRKRP=(TTRK3+TTRK1+TTRK2)*0.3

THESE ARE THE NUMBER OF MECHANICS AVAILABLE AND THE ALLOWABLE
WORKLOAD IN MANHOURS FOR THE TWO MST'S.
      TAMEC3=90.0
      TAMEC1=40.0
      TAMEC2=40.0
      TM1AWL=160.0
      TM2AWL=160.0
      ARMEC3=25.0
      ARMEC1=10.0
      ARMEC2=10.0
      AM1AWL=40.0
      AM2AWL=40.0
      ELMEC3=10.0
      ELMEC1=5.0
      ELMEC2=5.0
      EM1AWL=20.0
      EM2AWL=20.0
      FCMEC3=10.0
      FCMEC1=7.0
      FCMEC2=7.0
      FM1AWL=28.0
      FM2AWL=28.0

THESE VALUES ARE THE MECHANICS REQUIRED, THE TIME TO REPAIR
EACH TYPE OF DAMAGE AND TOTAL MANHOURS PER JOB.

      TENGMR=3.0
      TENGTR=2.5
      TENGMH=7.5
      TXMNMR=3.0
      TXMNTR=2.5
      TXMNMH=7.5
      TXFRMR=3.0
      TXFRTR=2.0
      TXFRMH=6.0
      TTRKMR=2.0
      TTRKTR=8.0
      TTRKMH=16.0
      TFDRMR=3.0
      TFDRTR=2.5
```

```
TFDRMH=7.5
TFCNMR=2.0
TFCNTR=3.5
TFCNMH=7.5
TARMMR=2.0
TARMTR=4.5
TARMMH=9.0
TELEMR=2.0
TELETR=9.0
TELEMH=18.0

DO 11 J=1,15
EVACT1(J)=TIME + 2.0
EVACT2(J)=TIME +3.0
READ,TANKD1,TANKD2,TANKD3
TIME=TIME+1.0
```

2. EMPIRICAL PROBABILITY DENSITY FUNCTIONS

THE FOLLOWING CALCULATES THE AMOUNT OF DAMAGE PER CATEGORY BY VEHICLE CLASSIFICATION

```
TNKDES=(TANKD1+TANKD2+TANKD3)*0.16471
TENGD1=TANKD1*0.06353
TXMND1=TANKD1*0.08706
TXFRD1=TANKD1*0.05883
TTRKD1=TANKD1*0.31999
TFDRD1=TANKD1*0.00
TFCND1=TANKD1*0.08706
TARMD1=TANKD1*0.10353
TELED1=TANKD1*0.11529
TENGD3=TANKD3*0.06353
TXMND3=TANKD3*0.08706
TXFRD3=TANKD3*0.05883
TTRKD3=TANKD3*0.31999
TFDRD3=TANKD3*0.00
TFCND3=TANKD3*0.08706
TARMD3=TANKD3*0.10353
TELED3=TANKD3*0.11529
TENGD2=TANKD2*0.06353
TXMND2=TANKD2*0.08706
TXFRD2=TANKD2*0.05833
TTRKD2=TANKD2*0.31999
```

```
TFDRD2=TANKD2*0.00
TFCND2=TANKD2*0.08706
TARMD2=TANKD2*0.10353
TELED2=TANKD2*0.11529
TANKOR=(TANKS-(TANKD1+TANKD2+TANKD3))/TANKS
```

3. REPAIR AND RETURN QUEUES

This section cycles through the return time queues to determine which vehicle repair jobs have been completed. It then adjusts the total number of vehicles which are under repair and increments the number of mechanics available for repair.

```
IF(J.EQ.1)THEN
GO TO 400
ELSE
N=J-1
END IF
DO 993 K=1,N
```

Tank engines repaired

```
IF(TENRT1(K).LE.TIME)THEN
   TENRR1(J)=TENUR1(K)
   TEUR1T=TEUR1T-TENUR1(K)
   TERT1=TERT1+TENRR1(J)
   TAMEC1=TAMEC1+(TENUR1(K)*TENGMR)
   TENUR1(K)=0.0
ELSE
END IF
```

Tank transmissions repaired

```
IF(TXMRT1(K).LE.TIME)THEN
   TXMRR1(J)=TXMUR1(K)
   TXUR1T=TXUR1T-TXMUR1(K)
   TXRT1=TXRT1+TXMRR1(J)
   TAMEC1=TAMEC1+(TXMUR1(K)*TXMNMR)
   TXMUR1(K)=0.0
ELSE
   END IF
```

Tank transfers repaired

```
   IF( TXFRT1( K). LE. TIME)THEN
      TXFRR1( J)=TXFUR1( K)
      TFUR1T=TFUR1T-TXFUR1( K)
      TFRT1=TFRT1+TXFRR1( J)
      TAMEC1=TAMEC1+( TXFUR1( K)*TXFRMR)
      TXFUR1( K)=0. 0
   ELSE
      END IF
```

Tank final drive repaired

```
   IF( TFDRT1( K). LE. TIME)THEN
      TFDRR1( J)=TFDUR1( K)
      TDUR1T=TDUR1T-TFDUR1( K)
      TDRT1=TDRT1+TFDRR1( J)
      TAMEC1=TAMEC1+( TFDUR1( K)*TFDRMR)
      TFDUR1( K)=0. 0
   ELSE
      END IF
```

Tank track repaired

```
   IF( TTRRT1( K). LE. TIME)THEN
      TTRRR1( J)=TTRUR1( K)
      TTUR1T=TTUR1T-TTRUR1( K)
      TTRT1=TTRT1+TTRRR1( J)
      TAMEC1=TAMEC1+( TTRUR1( K)*TTRKMR)
      TTRUR1( K)=0. 0
   ELSE
      END IF
```

Tank fire control repaired

```
   IF( TFCRT1( K). LE. TIME)THEN
      TFCRR1( J)=TFCUR1( K)
      TCUR1T=TCUR1T-TFCUR1( K)
      TCRT1=TCRT1+TFCRR1( J)
      FCMEC1=FCMEC1+( TFCUR1( K)*TFCNMR)
      TFCUR1( K)=0. 0
   ELSE
      END IF
```

Tank electrical system repaired

```
   IF( TELRT1( K). LE. TIME)THEN
      TELRR1( J)=TELUR1( K)
      TLUR1T=TLUR1T-TELUR1( K)
      TLRT1=TLRT1+TELRR1( J)
```

```
      ELMEC1=ELMEC1+(TELUR1(K)*TELEMR)
      TELUR1(K)=0.0
   ELSE
      END IF
```

Tank armament system repaired

```
   IF(TARRT1(K).LE.TIME)THEN
      TARRR1(J)=TARUR1(K)
      TAUR1T=TAUR1T-TARUR1(K)
      TART1=TART1+TARRR1(J)
      ARMEC1=ARMEC1+(TARUR1(K)*TARMMR)
      TARUR1(K)=0.0
   ELSE
      END IF
```

The remaining code in this format determine the repaired components for MST 2 and the rear DS company

```
   IF(TENRT2(K).LE.TIME)THEN
      TENRR2(J)=TENUR2(K)
      TEUR2T=TEUR2T-TENUR2(K)
      TERT2=TERT2+TENRR2(J)
      TAMEC2=TAMEC2+(TENUR2(K)*TENGMR)
      TENUR2(K)=0.0
   ELSE
      END IF

   IF(TXMRT2(K).LE.TIME)THEN
      TXMRR2(J)=TXMUR2(K)
      TXUR2T=TXUR2T-TXMUR2(K)
      TXRT2=TXRT2+TXMRR2(J)
      TAMEC2=TAMEC2+(TXMUR2(K)*TXMNMR)
      TXMUR2(K)=0.0
   ELSE
      END IF

   IF(TXFRT2(K).LE.TIME)THEN
      TXFRR2(J)=TXFUR2(K)
      TFUR2T=TFUR2T-TXFUR2(K)
      TFRT2=TFRT2+TXFRR2(J)
      TAMEC2=TAMEC2+(TXFUR2(K)*TXFRMR)
      TXFUR2(K)=0.0
   ELSE
      END IF

   IF(TFDRT2(K).LE.TIME)THEN
```

```
    TFDRR2(J)=TFDUR2(K)
    TDUR2T=TDUR2T-TFDUR2(K)
    TDRT2=TDRT2+TFDRR2(J)
    TAMEC2=TAMEC2+(TFDUR2(K)*TFDRMR)
    TFDUR2(K)=0.0
ELSE
    END IF

IF(TTRRT2(K).LE.TIME)THEN
    TTRRR2(J)=TTRUR2(K)
    TTUR2T=TTUR2T-TTRUR2(K)
    TTRT2=TTRT2+TTRRR2(J)
    TAMEC2=TAMEC2+(TTRUR2(K)*TTRKMR)
    TTRUR2(K)=0.0
ELSE
    END IF

IF(TFCRT2(K).LE.TIME)THEN
    TFCRR2(J)=TFCUR2(K)
    TCUR2T=TCUR2T-TFCUR2(K)
    TCRT2=TCRT2+TFCRR2(J)
    FCMEC2=FCMEC2+(TFCUR2(K)*TFCNMR)
    TFCUR2(K)=0.0
ELSE
    END IF

IF(TELRT2(K).LE.TIME)THEN
    TELRR2(J)=TELUR2(K)
    TLUR2T=TLUR2T-TELUR2(K)
    TLRT2=TLRT2+TELRR2(J)
    ELMEC2=ELMEC2+(TELUR2(K)*TELEMR)
    TELUR2(K)=0.0
ELSE
    END IF

IF(TARRT2(K).LE.TIME)THEN
    TARRR2(J)=TARUR2(K)
    TAUR2T=TAUR2T-TARUR2(K)
    TART2=TART2+TARRR2(J)
    ARMEC2=ARMEC2+(TARUR2(K)*TARMMR)
    TARUR2(K)=0.0
ELSE
    END IF

IF(TENRT3(K).LE.TIME)THEN
```

```
    TENRR3(J)=TENUR3(K)
    TEUR3T=TEUR3T-TENUR3(K)
    TERT3=TERT3+TENRR3(J)
    TAMEC3=TAMEC3+(TENUR3(K)*TENGMR)
    TENUR3(K)=0.0
ELSE
    END IF

IF(TXMRT3(K).LE.TIME)THEN
    TXMRR3(J)=TXMUR3(K)
    TXUR3T=TXUR3T-TXMUR3(K)
    TXRT3=TXRT3+TXMRR3(J)
    TAMEC3=TAMEC3+(TXMUR3(K)*TXMNMR)
    TXMUR3(K)=0.0
ELSE
    END IF

IF(TXFRT3(K).LE.TIME)THEN
    TXFRR3(J)=TXFUR3(K)
    TFUR3T=TFUR3T-TXFUR3(K)
    TFRT3=TFRT3+TXFRR3(J)
    TAMEC3=TAMEC3+(TXFUR3(K)*TXFRMR)
    TXFUR3(K)=0.0
ELSE
    END IF

IF(TFDRT3(K).LE.TIME)THEN
    TFDRR3(J)=TFDUR3(K)
    TDUR3T=TDUR3T-TFDUR3(K)
    TDRT3=TDRT3+TFDRR3(J)
    TAMEC3=TAMEC3+(TFDUR3(K)*TFDRMR)
    TFDUR3(K)=0.0
ELSE
    END IF

IF(TTRRT3(K).LE.TIME)THEN
    TTRRR3(J)=TTRUR3(K)
    TTUR3T=TTUR3T-TTRUR3(K)
    TTRT3=TTRT3+TTRRR3(J)
    TAMEC3=TAMEC3+(TTRUR3(K)*TTRKMR)
    TTRUR3(K)=0.0
ELSE
    END IF

IF(TFCRT3(K).LE.TIME)THEN
    TFCRR3(J)=TFCUR3(K)
```

```
          TCUR3T=TCUR3T-TFCUR3(K)
          TCRT3=TCRT3+TFCRR3(J)
          FCMEC3=FCMEC3+(TFCUR3(K)*TFCNMR)
          TFCUR3(K)=0.0
       ELSE
          END IF

       IF(TELRT3(K).LE.TIME)THEN
          TELRR3(J)=TELUR3(K)
          TLUR3T=TLUR3T-TELUR3(K)
          TLRT3=TLRT3+TELRR3(J)
          ELMEC3=ELMEC3+(TELUR3(K)*TELEMR)
          TELUR3(K)=0.0
       ELSE
          END IF

       IF(TARRT3(K).LE.TIME)THEN
          TARRR3(J)=TARUR3(K)
          TAUR3T=TAUR3T-TARUR3(K)
          TART3=TART3+TARRR3(J)
          ARMEC3=ARMEC3+(TARUR3(K)*TARMMR)
          TARUR3(K)=0.0
       ELSE
          END IF

993    CONTINUE
```

4. WAITING MECHANIC QUEUES

These are the routines that cycle through the waiting mechanic queues and the mechanic availability to determine if vehicles that had been in a waiting mechanic status can transfer to an under repair status.

```
400    IF(J.EQ.1)THEN
       GO TO 401
       ELSE
       L=J-1
       END IF
       DO 991 K=1,L
```

Tank engines waiting mechanics

```
      IF(TENWM1(K).GT.0.0)THEN
       TTENM1=TENWM1(K)*TENGMR
        ELSE
             GO TO 100
        END IF
           IF(TAMEC1.GT.0.0)THEN
                RATIO=TTENM1/TAMEC1
           ELSE
                GO TO 100
             END IF
             IF(RATIO.LE.1.0)THEN
                  TENUR1(J)=TENUR1(J)+TENWM1(K)
                  TAMEC1=TAMEC1-TTENM1
                  TEWM1T=TEWM1T-TENWM1(K)
                  TENWM1(K)=0.0
             ELSE
                  TENUR1(J)=TENUR1(J)+(TENWM1(K)/RATIO)
                  TEWM1T=TEWM1T-(TENWM1(K)/RATIO)
                  TENWM1(K)=TENWM1(K)-(TENWM1(K)/RATIO)
                  TAMEC1=0.0
             ENDIF
```

Tank transmissions waiting mechanics

```
100   IF(TXMWM1(K).GT.0.0)THEN
         TTXMM1=TXMWM1(K)*TXMNMR
      ELSE
         GO TO 101
      END IF
              IF(TAMEC1.GT.0.0)THEN
                  RATIO=TTXMM1/TAMEC1
              ELSE
                   GO TO 101
              END IF
              IF(RATIO.LE.1.0)THEN
                   TXMUR1(J)=TXMUR1(J)+TXMWM1(K)
                   TAMEC1=TAMEC1-TTXMM1
                   TXWM1T=TXWM1T-TXMWM1(K)
                   TXMWM1(K)=0.0
              ELSE
                   TXMUR1(J)=TXMUR1(J)+(TXMWM1(K)/RATIO)
                   TXWM1T=TXWM1T-(TXMWM1(K)/RATIO)
                   TXMWM1(K)=TXMWM1(K)-(TXMWM1(K)/RATIO)
                   TAMEC1=0.0
              ENDIF
```

Tank transfers waiting mechanics

```
101   IF(TXFWM1(K).GT.0.0)THEN
```

```
      TTXFM1=TXFWM1(K)*TXFRMR
   ELSE
      GO TO 102
   END IF
           IF(TAMEC1.GT.0.0)THEN
      RATIO=TTXFM1/TAMEC1
           ELSE
                GO TO 102
           END IF
           IF(RATIO.LE.1.0)THEN
                TXFUR1(J)=TXFUR1(J)+TXFWM1(K)
                TAMEC1=TAMEC1-TTXFM1
                TFWM1T=TFWM1T-TXFWM1(K)
                TXFWM1(K)=0.0
           ELSE
                TXFUR1(J)=TXFUR1(J)+(TXFWM1(K)/RATIO)
                TFWM1T=TFWM1T-(TXFWM1(K)/RATIO)
                TXFWM1(K)=TXFWM1(K)-(TXFWM1(K)/RATIO)
                TAMEC1=0.0
           ENDIF
```

Tank track waiting mechanics

```
102   IF(TTRWM1(K).GT.0.0)THEN
         TTTRM1=TTRWM1(K)*TTRKMR
      ELSE
         GO TO 123
      END IF
              IF(TAMEC1.GT.0.0)THEN
         RATIO=TTTRM1/TAMEC1
         ELSE
              GO TO 123
         END IF
              IF(RATIO.LE.1.0)THEN
                   TTRUR1(J)=TTRUR1(J)+TTRWM1(K)
                   TAMEC1=TAMEC1-TTTRM1
                   TTWM1T=TTWM1T-TTRWM1(K)
                   TTRWM1(K)=0.0
              ELSE
                   TTRUR1(J)=TTRUR1(J)+(TTRWM1(K)/RATIO)
                   TTWM1T=TTWM1T-(TTRWM1(K)/RATIO)
                   TTRWM1(K)=TTRWM1(K)-(TTRWM1(K)/RATIO)
                   TAMEC1=0.0
              ENDIF
```

Tank final drive waiting mechanic

```
123   IF(TFDWM1(K).GT.0.0)THEN
         TTFDM1=TFDWM1(K)*TFDRMR
      ELSE
```

```
   GO TO 108
END IF
        IF(TAMEC1.GT.0.0)THEN
   RATIO=TTFDM1/TAMEC1
ELSE
   GO TO 108
   END IF
        IF(RATIO.LE.1.0)THEN
             TFDUR1(J)=TFDUR1(J)+TFDWM1(K)
             TAMEC1=TAMEC1-TTFDM1
             TDWM1T=TDWM1T-TFDWM1(K)
             TFDWM1(K)=0.0
        ELSE
             TFDUR1(J)=TFDUR1(J)+(TFDWM1(K)/RATIO)
             TDWM1T=TDWM1T-(TFDWM1(K)/RATIO)
             TFDWM1(K)=TFDWM1(K)-(TFDWM1(K)/RATIO)
             TAMEC1=0.0
        ENDIF
```

Tank armament waiting mechanics

```
108   IF(TARWM1(K).GT.0.0)THEN
         TTARM1=TARWM1(K)*TARMMR
      ELSE
         GO TO 110
      END IF
              IF(ARMEC1.GT.0.0)THEN
         RATIO=TTARM1/ARMEC1
      ELSE
         GO TO 110
      END IF
              IF(RATIO.LE.1.0)THEN
                   TARUR1(J)=TARUR1(J)+TARWM1(K)
                   ARMEC1=ARMEC1-TTARM1
                   TAWM1T=TAWM1T-TARWM1(K)
                   TARWM1(K)=0.0
              ELSE
                   TARUR1(J)=TARUR1(J)+(TARWM1(K)/RATIO)
                   TAWM1T=TAWM1T-(TARWM1(K)/RATIO)
                   TARWM1(K)=TARWM1(K)-(TARWM1(K)/RATIO)
                   ARMEC1=0.0
              ENDIF
```

Tank electrical waiting mechanics

```
110   IF(TELWM1(K).GT.0.0)THEN
         TTELM1=TELWM1(K)*TELEMR
      ELSE
         GO TO 112
      END IF
```

```
             IF(ELMEC1.GT.0.0)THEN
        RATIO=TTELM1/ELMEC1
     ELSE
        GO TO 112
     END IF
             IF(RATIO.LE.1.0)THEN
                  TELUR1(J)=TELUR1(J)+TELWM1(K)
                  ELMEC1=ELMEC1-TTELM1
                  TLWM1T=TLWM1T-TELWM1(K)
                  TELWM1(K)=0.0
             ELSE
                  TELUR1(J)=TELUR1(J)+(TELWM1(K)/RATIO)
                  TLWM1T=TLWM1T-(TELWM1(K)/RATIO)
                  TELWM1(K)=TELWM1(K)-(TELWM1(K)/RATIO)
                  ELMEC1=0.0
             ENDIF
```

Tank fire control waiting mechanics

```
112  IF(TFCWM1(K).GT.0.0)THEN
        TTFCM1=TFCWM1(K)*TFCNMR
     ELSE
        GO TO 114
     END IF
             IF(FCMEC1.GT.0.0)THEN
        RATIO=TTFCM1/FCMEC1
     ELSE
        GO TO 114
     END IF
             IF(RATIO.LE.1.0)THEN
                  TFCUR1(J)=TFCUR1(J)+TFCWM1(K)
                  FCMEC1=FCMEC1-TTFCM1
                  TCWM1T=TCWM1T-TFCWM1(K)
                  TFCWM1(K)=0.0
             ELSE
                  TFCUR1(J)=TFCUR1(J)+(TFCWM1(K)/RATIO)
                  TCWM1T=TCWM1T-(TFCWM1(K)/RATIO)
                  TFCWM1(K)=TFCWM1(K)-(TFCWM1(K)/RATIO)
                  FCMEC1=0.0
             ENDIF
```

This section of code is for the components damaged that are waiting mechanics at MST 2 and the rear DS company

```
114   IF(TENWM2(K).GT.0.0)THEN
       TTENM2=TENWM2(K)*TENGMR
        ELSE
             GO TO 119
        END IF
           IF(TAMEC2.GT.0.0)THEN
```

```
            RATIO=TTENM2/TAMEC2
        ELSE
            GO TO 119
          END IF
          IF(RATIO.LE.1.0)THEN
                TENUR2(J)=TENUR2(J)+TENWM2(K)
                TAMEC2=TAMEC2-TTENM2
                TEWM2T=TEWM2T-TENWM2(K)
                TENWM2(K)=0.0
          ELSE
                TENUR2(J)=TENUR2(J)+(TENWM2(K)/RATIO)
                TEWM2T=TEWM2T-(TENWM2(K)/RATIO)
                TENWM2(K)=TENWM2(K)-(TENWM2(K)/RATIO)
                TAMEC2=0.0
          ENDIF

119   IF(TXMWM2(K).GT.0.0)THEN
         TTXMM2=TXMWM2(K)*TXMNMR
      ELSE
         GO TO 120
      END IF
              IF(TAMEC2.GT.0.0)THEN
                  RATIO=TTXMM2/TAMEC2
              ELSE
                  GO TO 120
              END IF
              IF(RATIO.LE.1.0)THEN
                  TXMUR2(J)=TXMUR2(J)+TXMWM2(K)
                  TAMEC2=TAMEC2-TTXMM2
                  TXWM2T=TXWM2T-TXMWM2(K)
                  TXMWM2(K)=0.0
              ELSE
                  TXMUR2(J)=TXMUR2(J)+(TXMWM2(K)/RATIO)
                  TXWM2T=TXWM2T-(TXMWM2(K)/RATIO)
                  TXMWM2(K)=TXMWM2(K)-(TXMWM2(K)/RATIO)
                  TAMEC2=0.0
              ENDIF

120   IF(TXFWM2(K).GT.0.0)THEN
         TTXFM2=TXFWM2(K)*TXFRMR
      ELSE
         GO TO 121
      END IF
              IF(TAMEC2.GT.0.0)THEN
         RATIO=TTXFM2/TAMEC2
              ELSE
                  GO TO 121
              END IF
```

```
              IF(RATIO.LE.1.0)THEN
                   TXFUR2(J)=TXFUR2(J)+TXFWM2(K)
                   TAMEC2=TAMEC2-TTXFM2
                   TFWM2T=TFWM2T-TXFWM2(K)
                   TXFWM2(K)=0.0
              ELSE
                   TXFUR2(J)=TXFUR2(J)+(TXFWM2(K)/RATIO)
                   TFWM2T=TFWM2T-(TXFWM2(K)/RATIO)
                   TXFWM2(K)=TXFWM2(K)-(TXFWM2(K)/RATIO)
                   TAMEC2=0.0
              ENDIF

121     IF(TTRWM2(K).GT.0.0)THEN
           TTTRM2=TTRWM2(K)*TTRKMR
        ELSE
           GO TO 122
        END IF
               IF(TAMEC2.GT.0.0)THEN
           RATIO=TTTRM2/TAMEC2
           ELSE
                GO TO 122
           END IF
                IF(RATIO.LE.1.0)THEN
                     TTRUR2(J)=TTRUR2(J)+TTRWM2(K)
                     TAMEC2=TAMEC2-TTTRM2
                     TTWM2T=TTWM2T-TTRWM2(K)
                     TTRWM2(K)=0.0
                ELSE
                     TTRUR2(J)=TTRUR2(J)+(TTRWM2(K)/RATIO)
                     TTWM2T=TTWM2T-(TTRWM2(K)/RATIO)
                     TTRWM2(K)=TTRWM2(K)-(TTRWM2(K)/RATIO)
                     TAMEC2=0.0
                ENDIF

122     IF(TFDWM2(K).GT.0.0)THEN
           TTFDM2=TFDWM2(K)*TFDRMR
        ELSE
           GO TO 130
        END IF
                IF(TAMEC2.GT.0.0)THEN
           RATIO=TTFDM2/TAMEC2
        ELSE
           GO TO 130
           END IF
                IF(RATIO.LE.1.0)THEN
                     TFDUR2(J)=TFDUR2(J)+TFDWM2(K)
                     TAMEC2=TAMEC2-TTFDM2
                     TDWM2T=TDWM2T-TFDWM2(K)
```

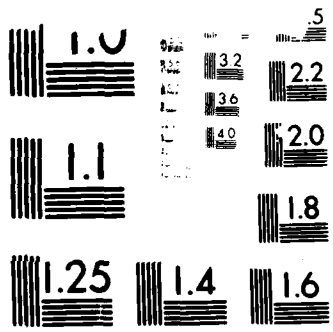
```
                 TFDWM2(K)=0.0
             ELSE
                 TFDUR2(J)=TFDUR2(J)+(TFDWM2(K)/RATIO)
                 TDWM2T=TDWM2T-(TFDWM2(K)/RATIO)
                 TFDWM2(K)=TFDWM2(K)-(TFDWM2(K)/RATIO)
                 TAMEC2=0.0
             ENDIF

 130     IF(TARWM2(K).GT.0.0)THEN
            TTARM2=TARWM2(K)*TARMMR
         ELSE
            GO TO 132
         END IF
                 IF(ARMEC2.GT.0.0)THEN
            RATIO=TTARM2/ARMEC2
         ELSE
            GO TO 132
         END IF
             IF(RATIO.LE.1.0)THEN
                 TARUR2(J)=TARUR2(J)+TARWM2(K)
                 ARMEC2=ARMEC2-TTARM2
                 TAWM2T=TAWM2T-TARWM2(K)
                 TARWM2(K)=0.0
             ELSE
                 TARUR2(J)=TARUR2(J)+(TARWM2(K)/RATIO)
                 TAWM2T=TAWM2T-(TARWM2(K)/RATIO)
                 TARWM2(K)=TARWM2(K)-(TARWM2(K)/RATIO)
                 ARMEC2=0.0
             ENDIF

 132     IF(TELWM2(K).GT.0.0)THEN
            TTELM2=TELWM2(K)*TELEMR
         ELSE
            GO TO 134
         END IF
                 IF(ELMEC2.GT.0.0)THEN
            RATIO=TTELM2/ELMEC2
         ELSE
            GO TO 134
         END IF
             IF(RATIO.LE.1.0)THEN
                 TELUR2(J)=TELUR2(J)+TELWM2(K)
                 ELMEC2=ELMEC2-TTELM2
                 TLWM2T=TLWM2T-TELWM2(K)
                 TELWM2(K)=0.0
             ELSE
                 TELUR2(J)=TELUR2(J)+(TELWM2(K)/RATIO)
                 TLWM2T=TLWM2T-(TELWM2(K)/RATIO)
```

AD-A168 515 BATTLEFIELD MAINTENANCE AND RECOVERY MODULE FOR THE AIRLAND RESEARCH MODEL(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA A W OLSEN MAR 86 2/2

UNCLASSIFIED F/G 15/5 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
3.2
3.6
4.0

```
                TELWM2(K)=TELWM2(K)-(TELWM2(K)/RATIO)
                ELMEC2=0.0
            ENDIF

134     IF(TFCWM2(K).GT.0.0)THEN
          TTFCM2=TFCWM2(K)*TFCNMR
        ELSE
          GO TO 136
        END IF
            IF(FCMEC2.GT.0.0)THEN
          RATIO=TTFCM2/FCMEC2
        ELSE
          GO TO 136
        END IF
            IF(RATIO.LE.1.0)THEN
                TFCUR2(J)=TFCUR2(J)+TFCWM2(K)
                FCMEC2=FCMEC2-TTFCM2
                TCWM2T=TCWM2T-TFCWM2(K)
                TFCWM2(K)=0.0
            ELSE
                TFCUR2(J)=TFCUR2(J)+(TFCWM2(K)/RATIO)
                TCWM2T=TCWM2T-(TFCWM2(K)/RATIO)
                TFCWM2(K)=TFCWM2(K)-(TFCWM2(K)/RATIO)
                FCMEC2=0.0
            ENDIF

136      IF(TENWM3(K).GT.0.0)THEN
          TTENM3=TENWM3(K)*TENGMR
           ELSE
               GO TO 137
           END IF
              IF(TAMEC3.GT.0.0)THEN
                  RATIO=TTENM3/TAMEC3
              ELSE
                  GO TO 137
               END IF
               IF(RATIO.LE.1.0)THEN
                   TENUR3(J)=TENUR3(J)+TENWM3(K)
                   TAMEC3=TAMEC3-TTENM3
                   TEWM3T=TEWM3T-TENWM3(K)
                   TENWM3(K)=0.0
               ELSE
                   TENUR3(J)=TENUR3(J)+(TENWM3(K)/RATIO)
                   TEWM3T=TEWM3T-(TENWM3(K)/RATIO)
                   TENWM3(K)=TENWM3(K)-(TENWM3(K)/RATIO)
                   TAMEC3=0.0
               ENDIF
```

```
137     IF( TXMWM3( K). GT. 0. 0)THEN
           TTXMM3=TXMWM3( K)*TXMNMR
        ELSE
           GO TO 138
        END IF
                IF( TAMEC3. GT. 0. 0)THEN
                    RATIO=TTXMM3/TAMEC3
                ELSE
                     GO TO 138
                END IF
                IF( RATIO. LE. 1. 0)THEN
                     TXMUR3( J)=TXMUR3( J)+TXMWM3( K)
                     TAMEC3=TAMEC3-TTXMM3
                     TXWM3T=TXWM3T-TXMWM3( K)
                     TXMWM3( K)=0. 0
                ELSE
                     TXMUR3( J)=TXMUR3( J)+( TXMWM3( K)/RATIO)
                     TXWM3T=TXWM3T-( TXMWM3( K)/RATIO)
                     TXMWM3( K)=TXMWM3( K)-( TXMWM3( K)/RATIO)
                     TAMEC3=0. 0
                ENDIF

138     IF( TXFWM3( K). GT. 0. 0)THEN
           TTXFM3=TXFWM3( K)*TXFRMR
        ELSE
           GO TO 139
        END IF
                IF( TAMEC3. GT. 0. 0)THEN
           RATIO=TTXFM3/TAMEC3
                ELSE
                     GO TO 139
                END IF
                IF( RATIO. LE. 1. 0)THEN
                     TXFUR3( J)=TXFUR3( J)+TXFWM3( K)
                     TAMEC3=TAMEC3-TTXFM3
                     TFWM3T=TFWM3T-TXFWM3( K)
                     TXFWM3( K)=0. 0
                ELSE
                     TXFUR3( J)=TXFUR3( J)+( TXFWM3( K)/RATIO)
                     TFWM3T=TFWM3T-( TXFWM3( K)/RATIO)
                     TXFWM3( K)=TXFWM3( K)-( TXFWM3( K)/RATIO)
                     TAMEC3=0. 0
                ENDIF

139     IF( TTRWM3( K). GT. 0. 0)THEN
           TTTRM3=TTRWM3( K)*TTRKMR
        ELSE
           GO TO 140
```

```
      END IF
            IF( TAMEC3.GT.0.0)THEN
         RATIO=TTTRM3/TAMEC3
         ELSE
             GO TO 140
         END IF
              IF( RATIO.LE.1.0)THEN
                  TTRUR3( J)=TTRUR3( J)+TTRWM3( K)
                  TAMEC3=TAMEC3-TTTRM3
                  TTWM3T=TTWM3T-TTRWM3( K)
                  TTRWM3( K)=0.0
              ELSE
                  TTRUR3( J)=TTRUR3( J)+( TTRWM3( K)/RATIO)
                  TTWM3T=TTWM3T-( TTRWM3( K)/RATIO)
                  TTRWM3( K)=TTRWM3( K)-( TTRWM3( K)/RATIO)
                  TAMEC3=0.0
              ENDIF

140   IF( TFDWM3( K).GT.0.0)THEN
         TTFDM3=TFDWM3( K)*TFDRMR
      ELSE
         GO TO 141
      END IF
              IF( TAMEC3.GT.0.0)THEN
         RATIO=TTFDM3/TAMEC3
      ELSE
         GO TO 141
         END IF
              IF( RATIO.LE.1.0)THEN
                  TFDUR3( J)=TFDUR3( J)+TFDWM3( K)
                  TAMEC3=TAMEC3-TTFDM3
                  TDWM3T=TDWM3T-TFDWM3( K)
                  TFDWM3( K)=0.0
              ELSE
                  TFDUR3( J)=TFDUR3( J)+( TFDWM3( K)/RATIO)
                  TDWM3T=TDWM3T-( TFDWM3( K)/RATIO)
                  TFDWM3( K)=TFDWM3( K)-( TFDWM3( K)/RATIO)
                  TAMEC3=0.0
              ENDIF

141   IF( TARWM3( K).GT.0.0)THEN
         TTARM3=TARWM3( K)*TARMMR
      ELSE
         GO TO 142
      END IF
              IF( ARMEC3.GT.0.0)THEN
         RATIO=TTARM3/ARMEC3
      ELSE
```

```
      GO TO 142
    END IF
            IF(RATIO.LE.1.0)THEN
                TARUR3(J)=TARUR3(J)+TARWM3(K)
                ARMEC3=ARMEC3-TTARM3
                TAWM3T=TAWM3T-TARWM3(K)
                TARWM3(K)=0.0
            ELSE
                TARUR3(J)=TARUR3(J)+(TARWM3(K)/RATIO)
                TAWM3T=TAWM3T-(TARWM3(K)/RATIO)
                TARWM3(K)=TARWM3(K)-(TARWM3(K)/RATIO)
                ARMEC3=0.0
            ENDIF

142 IF(TELWM3(K).GT.0.0)THEN
      TTELM3=TELWM3(K)*TELEMR
    ELSE
      GO TO 144
    END IF
            IF(ELMEC3.GT.0.0)THEN
      RATIO=TTELM3/ELMEC3
    ELSE
      GO TO 144
    END IF
            IF(RATIO.LE.1.0)THEN
                TELUR3(J)=TELUR3(J)+TELWM3(K)
                ELMEC3=ELMEC3-TTELM3
                TLWM3T=TLWM3T-TELWM3(K)
                TELWM3(K)=0.0
            ELSE
                TELUR3(J)=TELUR3(J)+(TELWM3(K)/RATIO)
                TLWM3T=TLWM3T-(TELWM3(K)/RATIO)
                TELWM3(K)=TELWM3(K)-(TELWM3(K)/RATIO)
                ELMEC3=0.0
            ENDIF

144 IF(TFCWM3(K).GT.0.0)THEN
      TTFCM3=TFCWM3(K)*TFCNMR
    ELSE
      GO TO 146
    END IF
            IF(FCMEC3.GT.0.0)THEN
      RATIO=TTFCM3/FCMEC3
    ELSE
      GO TO 146
    END IF
            IF(RATIO.LE.1.0)THEN
                TFCUR3(J)=TFCUR3(J)+TFCWM3(K)
```

```
                FCMEC3=FCMEC3-TTFCM3
                TCWM3T=TCWM3T-TFCWM3(K)
                TFCWM3(K)=0.0
            ELSE
                TFCUR3(J)=TFCUR3(J)+(TFCWM3(K)/RATIO)
                TCWM3T=TCWM3T-(TFCWM3(K)/RATIO)
                TFCWM3(K)=TFCWM3(K)-(TFCWM3(K)/RATIO)
                FCMEC3=0.0
            ENDIF
991   CONTINUE
```

5. QUEUE ALLOCATION ROUTINES

This routine takes the data from the empirical distribution function and makes the initial assignments to the three major queues; under repair, waiting parts or waiting mechanics.

Tank engine

```
401   TOTAL=TENGD1+TENUR1(J)
      IF(TOTAL.EQ.0.0)GO TO 1
                IF(TENGD1.LE.TENG1)THEN
                    TENWR1=TOTAL
                    TENG1=TENG1-TENGD1
                ELSE
                    TENWR1=TENG1
                    TENWP1(J)=TENGD1-TENG1
                    TENG1=0.0
                END IF
      TTENM1=TENWR1*TENGMR
      IF(TTENM1.LE.TAMEC1)THEN
         TENUR1(J)=TENUR1(J)+TENWR1
         TAMEC1=TAMEC1-TTENM1
      ELSE
         TENUR1(J)=TENUR1(J)+(TAMEC1/TTENM1)*TENWR1
         TENWM1(J)=TENWM1(J)+TENGD1-(TAMEC1/TTENM1)*TENWR1-TENWP1(J)
         TAMEC1=0.0
      END IF
      TENRT1(J)=TIME+TENGTR
      TEUR1T=TEUR1T+TENUR1(J)
      TEWP1T=TEWP1T+TENWP1(J)
```

```
      TEWM1T=TEWM1T+TENWM1(J)
      TENWL1=TEWM1T*TENGMH

1     TOTAL=TENGD2+TENUR2(J)
         IF(TOTAL.EQ.0.0)GO TO 2
               IF(TENGD2.LE.TENG2)THEN
                 TENWR2=TENGD2
                 TENG2=TENG2-TENGD2
               ELSE
                 TENWR2=TENG2
                 TENWP2(J)=TENGD2-TENG2
                 TENG2=0.0
               END IF
      TTENM2=TENWR2*TENGMR
      IF(TTENM2.LE.TAMEC2)THEN
         TENUR2(J)=TENUR2(J)+TENWR2
         TAMEC2=TAMEC2-TTENM2
      ELSE
         TENUR2(J)=TENUR2(J)+(TAMEC2/TTENM2)*TENWR2
         TENWM2(J)=TENWM2(J)+TENGD2-(TAMEC2/TTENM2)*TENWR2-TENWP2(J)
         TAMEC2=0.0
      END IF
      TENRT2(J)=TIME+TENGTR
      TEUR2T=TEUR2T+TENUR2(J)
      TEWP2T=TEWP2T+TENWP2(J)
      TEWM2T=TEWM2T+TENWM2(J)
      TENWL2=TEWM2T*TENGMH

2     TENGD3=TENGD3+ETEWR1+ETEWR2
      TOTAL=TENGD3+TENUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 3
       IF(TENGD3.LE.TENG3)THEN
         TENWR3=TENGD3
         TENG3=TENG3-TENGD3
      ELSE
         TENWR3=TENG3
         TENWP3(J)=TENGD3-TENG3
         TENG3=0.0
      END IF
      TTENM3=TENWR3*TENGMR
      IF(TTENM3.LE.TAMEC3)THEN
         TENUR3(J)=TENUR3(J)+TENWR3
         TAMEC3=TAMEC3-TTENM3
      ELSE
         TENUR3(J)=TENUR3(J)+(TAMEC3/TTENM3)*TENWR3
         TENWM3(J)=TENWM3(J)+TENGD3-(TAMEC3/TTENM3)*TENWR3-TENWP3(J)
         TAMEC3=0.0
      END IF
      TENRT3(J)=TIME+TENGTR
```

```
      TEUR3T=TEUR3T+TENUR3(J)
      TEWP3T=TEWP3T+TENWP3(J)
      TEWM3T=TEWM3T+TENWM3(J)
      TENWL3=TEWM3T*TENGMH

    Tank transmissions

3     TOTAL=TXMND1+TXMUR1(J)
      IF(TOTAL.EQ.0.0)GO TO 4
      IF(TXMND1.LE.TXMN1)THEN
         TXMWR1=TXMND1
         TXMN1=TXMN1-TXMND1
      ELSE
         TXMWR1=TXMN1
         TXMWP1(J)=TXMND1-TXMN1
         TXMN1=0.0
      END IF
      TTXMM1=TXMWR1*TXMNMR
      IF(TTXMM1.LE.TAMEC1)THEN
         TXMUR1(J)=TXMUR1(J)+TXMWR1
         TAMEC1=TAMEC1-TTXMM1
      ELSE
         TXMUR1(J)=TXMUR1(J)+(TAMEC1/TTXMM1)*TXMWR1
         TXMWM1(J)=TXMWM1(J)+TXMND1-(TAMEC1/TTXMM1)*TXMWR1-TXMWP1(J)
         TAMEC1=0.0
      END IF
      TXMRT1(J)=TIME+TXMNTR
      TXUR1T=TXUR1T+TXMUR1(J)
      TXWP1T=TXWP1T+TXMWP1(J)
      TXWM1T=TXWM1T+TXMWM1(J)
      TXMWL1=TXWM1T*TXMNMH

4     TOTAL=TXMND2+TXMUR2(J)
      IF(TOTAL.EQ.0.0)GO TO 5
      IF(TXMND2.LE.TXMN2)THEN
         TXMWR2=TXMND2
         TXMN2=TXMN2-TXMND2
      ELSE
         TXMWR2=TXMN2
         TXMWP2(J)=TXMND2-TXMN2
         TXMN2=0.0
      END IF
      TTXMM2=TXMWR2*TXMNMR
      IF(TTXMM2.LE.TAMEC2)THEN
         TXMUR2(J)=TXMUR2(J)+TXMWR2
         TAMEC2=TAMEC2-TTXMM2
      ELSE
         TXMUR2(J)=TXMUR2(J)+(TAMEC2/TTXMM2)*TXMWR2
         TXMWM2(J)=TXMWM2(J)+TXMND2-(TAMEC2/TTXMM2)*TXMWR2-TXMWP2(J)
         TAMEC2=0.0
```

```
      END IF
      TXMRT2(J)=TIME+TXMNTR
      TXUR2T=TXUR2T+TXMUR2(J)
      TXWP2T=TXWP2T+TXMWP2(J)
      TXWM2T=TXWM2T+TXMWM2(J)
      TXMWL2=TXWM2T*TXMNMH

5     TXMND3=TXMND3+ETXWR1+ETXWR2
      TOTAL=TXMND3+TXMUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 6
      IF(TXMND3.LE.TXMN3)THEN
         TXMWR3=TXMND3
         TXMN3=TXMN3-TXMND3
      ELSE
         TXMWR3=TXMN3
         TXMWP3(J)=TXMND3-TXMN3
         TXMN3=0.0
      END IF
      TTXMM3=TXMWR3*TXMNMR
      IF(TTXMM3.LE.TAMEC3)THEN
         TXMUR3(J)=TXMUR3(J)+TXMWR3
         TAMEC3=TAMEC3-TTXMM3
      ELSE
         TXMUR3(J)=TXMUR3(J)+(TAMEC3/TTXMM3)*TXMWR3
         TXMWM3(J)=TXMWM3(J)+TXMND3-(TAMEC3/TTXMM3)*TXMWR3-TXMWP3(J)
         TAMEC3=0.0
      END IF
      TXMRT3(J)=TIME+TXMNTR
      TXMWL3=TXMWM3(J)*TXMNMH
      TXUR3T=TXUR3T+TXMUR3(J)
      TXWP3T=TXWP3T+TXMWP3(J)
      TXWM3T=TXWM3T+TXMWM3(J)

     Tank transfers

6     TOTAL=TXFRD1+TXFUR1(J)
      IF(TOTAL.EQ.0.0)GO TO 7
      IF(TXFRD1.LE.TXFR1)THEN
         TXFWR1=TXFRD1
         TXFR1=TXFR1-TXFRD1
      ELSE
         TXFWR1=TXFR1
         TXFWP1(J)=TXFRD1-TXFR1
         TXFR1=0.0
      END IF
      TTXFM1=TXFWR1*TXFRMR
      IF(TTXFM1.LE.TAMEC1)THEN
         TXFUR1(J)=TXFUR1(J)+TXFWR1
         TAMEC1=TAMEC1-TTXFM1
      ELSE
```

```
         TXFUR1(J)=TXFUR1(J)+(TAMEC1/TTXFM1)*TXFWR1
         TXFWM1(J)=TXFWM1(J)+TXFRD1-(TAMEC1/TTXFM1)*TXFWR1-TXFWP1(J)
         TAMEC1=0.0
      END IF
      TXFRT1(J)=TIME+TXFRTR
      TFUR1T=TFUR1T+TXFUR1(J)
      TFWP1T=TFWP1T+TXFWP1(J)
      TFWM1T=TFWM1T+TXFWM1(J)
      TXFWL1=TFWM1T*TXFRMH

7     TOTAL=TXFRD2+TXFUR2(J)
      IF(TOTAL.EQ.0.0)GO TO 8
      IF(TXFRD2.LE.TXFR2)THEN
         TXFWR2=TXFRD2
         TXFR2=TXFR2-TXFRD2
      ELSE
         TXFWR2=TXFR2
         TXFWP2(J)=TXFRD2-TXFR2
         TXFR2=0.0
      END IF
      TTXFM2=TXFWR2*TXFRMR
      IF(TTXFM2.LE.TAMEC2)THEN
         TXFUR2(J)=TXFUR2(J)+TXFWR2
         TAMEC2=TAMEC2-TTXFM2
      ELSE
         TXFUR2(J)=TXFUR2(J)+(TAMEC2/TTXFM2)*TXFWR2
         TXFWM2(J)=TXFWM2(J)+TXFRD2-(TAMEC2/TTXFM2)*TXFWR2-TXFWP2(J)
         TAMEC2=0.0
      END IF
      TXFRT2(J)=TIME+TXFRTR
      TFUR2T=TFUR2T+TXFUR2(J)
      TFWP2T=TFWP2T+TXFWP2(J)
      TFWM2T=TFWM2T+TXFWM2(J)
      TXFWL2=TFWM2T*TXFRMH

8     TXFRD3=TXFRD3+ETFWR1+ETFWR2
      TOTAL=TXFRD3+TXFUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 9
      IF(TXFRD3.LE.TXFR3)THEN
         TXFWR3=TXFRD3
         TXFR3=TXFR3-TXFRD3
      ELSE
         TXFWR3=TXFR3
         TXFWP3(J)=TXFRD3-TXFR3
         TXFR3=0.0
      END IF
      TTXFM3=TXFWR3*TXFRMR
      IF(TTXFM3.LE.TAMEC3)THEN
         TXFUR3(J)=TXFUR3(J)+TXFWR3
```

```
      TAMEC3=TAMEC3-TTXFM3
   ELSE
      TXFUR3(J)=TXFUR3(J)+(TAMEC3/TTXFM3)*TXFWR3
      TXFWM3(J)=TXFWM3(J)+TXFRD3-(TAMEC3/TTXFM3)*TXFWR3-TXFWP3(J)
      TAMEC3=0.0
   END IF
   TXFRT3(J)=TIME+TXFRTR
   TFUR3T=TFUR3T+TXFUR3(J)
   TFWP3T=TFWP3T+TXFWP3(J)
   TFWM3T=TFWM3T+TXFWM3(J)
   TXFWL3=TFWM3T*TXFRMH
```

Tank track

```
9  TOTAL=TTRKD1+TTRUR1(J)
   IF(TOTAL.EQ.0.0)GO TO 12
   IF(TTRKD1.LE.TTRK1)THEN
      TTRWR1=TTRKD1
      TTRK1=TTRK1-TTRKD1
   ELSE
      TTRWR1=TTRK1
      TTRWP1(J)=TTRKD1-TTRK1
      TTRK1=0.0
   END IF
   TTTRM1=TTRWR1*TTRKMR
   IF(TTTRM1.LE.TAMEC1)THEN
      TTRUR1(J)=TTRUR1(J)+TTRWR1
      TAMEC1=TAMEC1-TTTRM1
   ELSE
      TTRUR1(J)=TTRUR1(J)+(TAMEC1/TTTRM1)*TTRWR1
      TTRWM1(J)=TTRWM1(J)+TTRKD1-(TAMEC1/TTTRM1)*TTRWR1-TTRWP1(J)
      TAMEC1=0.0
   END IF
   TTRRT1(J)=TIME+TTRKTR
   TTUR1T=TTUR1T+TTRUR1(J)
   TTWP1T=TTWP1T+TTRWP1(J)
   TTWM1T=TTWM1T+TTRWM1(J)
   TTRWL1=TTWM1T*TTRKMH

12 TOTAL=TTRKD2+TTRUR2(J)
   IF(TOTAL.EQ.0.0)GO TO 13
   IF(TTRKD2.LE.TTRK2)THEN
      TTRWR2=TTRKD2
      TTRK2=TTRK2-TTRKD2
   ELSE
      TTRWR2=TTRK2
      TTRWP2(J)=TTRKD2-TTRK2
      TTRK2=0.0
   END IF
   TTTRM2=TTRWR2*TTRKMR
```

```
      IF(TTTRM2.LE.TAMEC2)THEN
         TTRUR2(J)=TTRUR2(J)+TTRWR2
         TAMEC2=TAMEC2-TTTRM2
      ELSE
         TTRUR2(J)=TTRUR2(J)+(TAMEC2/TTTRM2)*TTRWR2
         TTRWM2(J)=TTRWM2(J)+TTRKD2-(TAMEC2/TTTRM2)*TTRWR2-TTRWP2(J)
         TAMEC2=0.0
      END IF
      TTRRT2(J)=TIME+TTRKTR
      TTUR2T=TTUR2T+TTRUR2(J)
      TTWP2T=TTWP2T+TTRWP2(J)
      TTWM2T=TTWM2T+TTRWM2(J)
      TTRWL2=TTWM2T*TTRKMH

13    TTRKD3=TTRKD3+ETTWR1+ETTWR2
      TOTAL=TTRKD3+TTRUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 14
      IF(TTRKD3.LE.TTRK3)THEN
         TTRWR3=TTRKD3
         TTRK3=TTRK3-TTRKD3
      ELSE
         TTRWR3=TTRK3
         TTRWP3(J)=TTRKD3-TTRK3
         TTRK3=0.0
      END IF
      TTTRM3=TTRWR3*TTRKMR
      IF(TTTRM3.LE.TAMEC3)THEN
         TTRUR3(J)=TTRUR3(J)+TTRWR3
         TAMEC3=TAMEC3-TTTRM3
      ELSE
         TTRUR3(J)=TTRUR3(J)+(TAMEC3/TTTRM3)*TTRWR3
         TTRWM3(J)=TTRWM3(J)+TTRKD3-(TAMEC3/TTTRM3)*TTRWR3-TTRWP3(J)
         TAMEC3=0.0
      END IF
      TTRRT3(J)=TIME+TTRKTR
      TTUR3T=TTUR3T+TTRUR3(J)
      TTWP3T=TTWP3T+TTRWP3(J)
      TTWM3T=TTWM3T+TTRWM3(J)
      TTRWL3=TTWM3T*TTRKMH

    Tank final drives

14    TOTAL=TFDRD1+TFDUR1(J)
      IF(TOTAL.EQ.0.0)GO TO 15
      IF(TFDRD1.LE.TFDR1)THEN
         TFDWR1=TFDRD1
         TFDR1=TFDR1-TFDRD1
      ELSE
         TFDWR1=TFDR1
         TFDWP1(J)=TFDRD1-TFDR1
```

```
         TFDR1=0.0
      END IF
      TTFDM1=TFDWR1*TFDRMR
      IF(TTFDM1.LE.TAMEC1)THEN
         TFDUR1(J)=TFDUR1(J)+TFDWR1
         TAMEC1=TAMEC1-TTFDM1
      ELSE
         TFDUR1(J)=TFDUR1(J)+(TAMEC1/TTFDM1)*TFDWR1
         TFDWM1(J)=TFDWM1(J)+TFDRD1-(TAMEC1/TTFDM1)*TFDWR1-TFDWP1(J)
         TAMEC1=0.0
      END IF
      TFDRT1(J)=TIME+TFDRTR
      TDUR1T=TDUR1T+TFDUR1(J)
      TDWP1T=TDWP1T+TFDWP1(J)
      TDWM1T=TDWM1T+TFDWM1(J)
      TFDWL1=TDWM1T*TFDRMH
15    TOTAL=TFDRD2+TFDUR2(J)
      IF(TOTAL.EQ.0.0)GO TO 16
      IF(TFDRD2.LE.TFDR2)THEN
         TFDWR2=TFDRD2
         TFDR2=TFDR2-TFDRD2
      ELSE
         TFDWR2=TFDR2
         TFDWP2(J)=TFDRD2-TFDR2
         TFDR2=0.0
      END IF
      TTFDM2=TFDWR2*TFDRMR
      IF(TTFDM2.LE.TAMEC2)THEN
         TFDUR2(J)=TFDUR2(J)+TFDWR2
         TAMEC2=TAMEC2-TTFDM2
      ELSE
         TFDUR2(J)=TFDUR2(J)+(TAMEC2/TTFDM2)*TFDWR2
         TFDWM2(J)=TFDWM2(J)+TFDRD2-(TAMEC2/TTFDM2)*TFDWR2-TFDWP2(J)
         TAMEC2=0.0
      END IF
      TFDRT2(J)=TIME+TFDRTR
      TDUR2T=TDUR2T+TFDUR2(J)
      TDWP2T=TDWP2T+TFDWP2(J)
      TDWM2T=TDWM2T+TFDWM2(J)
      TFDWL2=TDWM2T*TFDRMH

16    TFDRD3=TFDRD3+ETDWR1+ETDWR2
      TOTAL=TFDRD3+TFDUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 17
      IF(TFDRD3.LE.TFDR3)THEN
         TFDWR3=TFDRD3
         TFDR3=TFDR3-TFDRD3
      ELSE
```

```
        TFDWR3=TFDR3
        TFDWP3(J)=TFDRD3-TFDR3
        TFDR3=0.0
     END IF
     TTFDM3=TFDWR3*TFDRMR
     IF(TTFDM3.LE.TAMEC3)THEN
        TFDUR3(J)=TFDUR3(J)+TFDWR3
        TAMEC3=TAMEC3-TTFDM3
     ELSE
        TFDUR3(J)=TFDUR3(J)+(TAMEC3/TTFDM3)*TFDWR3
        TFDWM3(J)=TFDWM3(J)+TFDRD3-(TAMEC3/TTFDM3)*TFDWR3-TFDWP3(J)
        TAMEC3=0.0
     END IF
     TFDRT3(J)=TIME+TFDRTR
     TDUR3T=TDUR3T+TFDUR3(J)
     TDWP3T=TDWP3T+TFDWP3(J)
     TDWM3T=TDWM3T+TFDWM3(J)
     TFDWL3=TDWM3T*TFDRMH

   Tank fire control systems

17   TOTAL=TFCND1+TFCUR1(J)
     IF(TOTAL.EQ.0.0)GO TO 18
     IF(TFCND1.LE.TFCN1)THEN
        TFCWR1=TFCND1
        TFCN1=TFCN1-TFCND1
     ELSE
        TFCWR1=TFCN1
        TFCWP1(J)=TFCND1-TFCN1
        TFCN1=0.0
     END IF
     TTFCM1=TFCWR1*TFCNMR
     IF(TTFCM1.LE.FCMEC1)THEN
        TFCUR1(J)=TFCUR1(J)+TFCWR1
        FCMEC1=FCMEC1-TTFCM1
     ELSE
        TFCUR1(J)=TFCUR1(J)+(FCMEC1/TTFCM1)*TFCWR1
        TFCWM1(J)=TFCWM1(J)+TFCND1-(FCMEC1/TTFCM1)*TFCWR1-TFCWP1(J)
        FCMEC1=0.0
     END IF
     TFCRT1(J)=TIME +TFCNTR
     TCUR1T=TCUR1T+TFCUR1(J)
     TCWP1T=TCWP1T+TFCWP1(J)
     TCWM1T=TCWM1T+TFCWM1(J)
     TFCWL1=TCWM1T*TFCNMH

18   TOTAL=TFCND2+TFCUR2(J)
     IF(TOTAL.EQ.0.0)GO TO 19
     IF(TFCND2.LE.TFCN2)THEN
        TFCWR2=TFCND2
```

```
        TFCN2=TFCN2-TFCND2
     ELSE
        TFCWR2=TFCN2
        TFCWP2(J)=TFCND2-TFCN2
        TFCN2=0.0
     END IF
     TTFCM2=TFCWR2*TFCNMR
     IF(TTFCM2.LE.FCMEC2)THEN
        TFCUR2(J)=TFCUR2(J)+TFCWR2
        FCMEC2=FCMEC2-TTFCM2
     ELSE
        TFCUR2(J)=TFCUR2(J)+(FCMEC2/TTFCM2)*TFCWR2
        TFCWM2(J)=TFCWM2(J)+TFCND2-(FCMEC2/TTFCM2)*TFCWR2-TFCWP2(J)
        FCMEC2=0.0
     END IF
     TFCRT2(J)=TIME +TFCNTR
     TCUR2T=TCUR2T+TFCUR2(J)
     TCWP2T=TCWP2T+TFCWP2(J)
     TCWM2T=TCWM2T+TFCWM2(J)
     TFCWL2=TCWM2T*TFCNMH


19   TFCND3=TFCND3+ETCWR1+ETCWR2
     TOTAL=TFCND3+TFCUR3(J)
     IF(TOTAL.EQ.0.0)GO TO 20
     IF(TFCND3.LE.TFCN3)THEN
        TFCWR3=TFCND3
        TFCN3=TFCN3-TFCND3
     ELSE
        TFCWR3=TFCN3
        TFCWP3(J)=TFCND3-TFCN3
        TFCN3=0.0
     END IF
     TTFCM3=TFCWR3*TFCNMR
     IF(TTFCM3.LE.FCMEC3)THEN
        TFCUR3(J)=TFCUR3(J)+TFCWR3
        FCMEC3=FCMEC3-TTFCM3
     ELSE
        TFCUR3(J)=TFCUR3(J)+(FCMEC3/TTFCM3)*TFCWR3
        TFCWM3(J)=TFCWM3(J)+TFCND3-(FCMEC3/TTFCM3)*TFCWR3-TFCWP3(J)
        FCMEC3=0.0
     END IF
     TFCRT3(J)=TIME +TFCNTR
     TCUR3T=TCUR3T+TFCUR3(J)
     TCWP3T=TCWP3T+TFCWP3(J)
     TCWM3T=TCWM3T+TFCWM3(J)
     TFCWL3=TCWM3T*TFCNMH
```

```
20    TOTAL=TARMD1+TARUR1(J)
      IF(TOTAL.EQ.0.0)GO TO 21
      IF(TARMD1.LE.TARM1)THEN
         TARWR1=TARMD1
         TARM1=TARM1-TARMD1
      ELSE
         TARWR1=TARM1
         TARWP1(J)=TARMD1-TARM1
         TARM1=0.0
      END IF
      TTARM1=TARWR1*TARMMR
      IF(TTARM1.LE.ARMEC1)THEN
         TARUR1(J)=TARUR1(J)+TARWR1
         ARMEC1=ARMEC1-TTARM1
      ELSE
         TARUR1(J)=TARUR1(J)+(ARMEC1/TTARM1)*TARWR1
         TARWM1(J)=TARWM1(J)+TARMD1-(ARMEC1/TTARM1)*TARWR1-TARWP1(J)
         ARMEC1=0.0
      END IF
      TARRT1(J)=TIME +TARMTR
      TAUR1T=TAUR1T+TARUR1(J)
      TAWP1T=TAWP1T+TARWP1(J)
      TAWM1T=TAWM1T+TARWM1(J)
      TARWL1=TAWM1T*TARMMH

21    TOTAL=TARMD2+TARUR2(J)
      IF(TOTAL.EQ.0.0)GO TO 22
      IF(TARMD2.LE.TARM2)THEN
         TARWR2=TARMD2
         TARM2=TARM2-TARMD2
      ELSE
         TARWR2=TARM2
         TARWP2(J)=TARMD2-TARM2
         TARM2=0.0
      END IF
      TTARM2=TARWR2*TARMMR
      IF(TTARM2.LE.ARMEC2)THEN
         TARUR2(J)=TARUR2(J)+TARWR2
         ARMEC2=ARMEC2-TTARM2
      ELSE
         TARUR2(J)=TARUR2(J)+(ARMEC2/TTARM2)*TARWR2
         TARWM2(J)=TARWM2(J)+TARMD2-(ARMEC2/TTARM2)*TARWR2-TARWP2(J)
         ARMEC2=0.0
      END IF
      TARRT2(J)=TIME +TARMTR
      TAUR2T=TAUR2T+TARUR2(J)
      TAWP2T=TAWP2T+TARWP2(J)
      TAWM2T=TAWM2T+TARWM2(J)
      TARWL2=TAWM2T*TARMMH
```

```
22    TARMD3=TARMD3+ETAWR1+ETAWR2
      TOTAL=TARMD3+TARUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 23
      IF(TARMD3.LE.TARM3)THEN
         TARWR3=TARMD3
         TARM3=TARM3-TARMD3
      ELSE
         TARWR3=TARM3
         TARWP3(J)=TARMD3-TARM3
         TARM3=0.0
      END IF
      TTARM3=TARWR3*TARMMR
      IF(TTARM3.LE.ARMEC3)THEN
         TARUR3(J)=TARUR3(J)+TARWR3
         ARMEC3=ARMEC3-TTARM3
      ELSE
         TARUR3(J)=TARUR3(J)+(ARMEC3/TTARM3)*TARWR3
         TARWM3(J)=TARWM3(J)+TARMD3-(ARMEC3/TTARM3)*TARWR3-TARWP3(J)
         ARMEC3=0.0
      END IF
      TARRT3(J)=TIME +TARMTR
      TAUR3T=TAUR3T+TARUR3(J)
      TAWP3T=TAWP3T+TARWP3(J)
      TAWM3T=TAWM3T+TARWM3(J)
      TARWL3=TAWM3T*TARMMH

   Tank electrical systems

23    TOTAL=TELED1+TELUR1(J)
      IF(TOTAL.EQ.0.0)GO TO 24
      IF(TELED1.LE.TELE1)THEN
         TELWR1=TELED1
         TELE1=TELE1-TELED1
      ELSE
         TELWR1=TELE1
         TELWP1(J)=TELED1-TELE1
         TELE1=0.0
      END IF
      TTELM1=TELWR1*TELEMR
      IF(TTELM1.LE.ELMEC1)THEN
         TELUR1(J)=TELUR1(J)+TELWR1
         ELMEC1=ELMEC1-TTELM1
      ELSE
         TELUR1(J)=TELUR1(J)+(ELMEC1/TTELM1)*TELWR1
         TELWM1(J)=TELWM1(J)+TELED1-(ELMEC1/TTELM1)*TELWR1-TELWP1(J)
         ELMEC1=0.0
      END IF
      TELRT1(J)=TIME +TELETR
```

```
      TLUR1T=TLUR1T+TELUR1(J)
      TLWP1T=TLWP1T+TELWP1(J)
      TLWM1T=TLWM1T+TELWM1(J)
      TELWL1=TLWM1T*TELEMH

24    TOTAL=TELED2+TELUR2(J)
      IF(TOTAL.EQ.0.0)GO TO 25
      IF(TELED2.LE.TELE2)THEN
         TELWR2=TELED2
         TELE2=TELE2-TELED2
      ELSE
         TELWR2=TELE2
         TELWP2(J)=TELED2-TELE2
         TELE2=0.0
      END IF
      TTELM2=TELWR2*TELEMR
      IF(TTELM2.LE.ELMEC2)THEN
         TELUR2(J)=TELUR2(J)+TELWR2
         ELMEC2=ELMEC2-TTELM2
      ELSE
         TELUR2(J)=TELUR2(J)+(ELMEC2/TTELM2)*TELWR2
         TELWM2(J)=TELWM2(J)+TELED2-(ELMEC2/TTELM2)*TELWR2-TELWP2(J)
         ELMEC2=0.0
      END IF
      TELRT2(J)=TIME +TELETR
      TLUR2T=TLUR2T+TELUR2(J)
      TLWP2T=TLWP2T+TELWP2(J)
      TLWM2T=TLWM2T+TELWM2(J)
      TELWL2=TLWM2T*TELEMH

25    TELED3=TELED3+ETLWR1+ETLWR2
      TOTAL=TELED3+TELUR3(J)
      IF(TOTAL.EQ.0.0)GO TO 26
      IF(TELED3.LE.TELE3)THEN
         TELWR3=TELED3
         TELE3=TELE3-TELED3
      ELSE
         TELWR3=TELE3
         TELWP3(J)=TELED3-TELE3
         TELE3=0.0
      END IF
      TTELM3=TELWR3*TELEMR
      IF(TTELM3.LE.ELMEC3)THEN
         TELUR3(J)=TELUR3(J)+TELWR3
         ELMEC3=ELMEC3-TTELM3
      ELSE
         TELUR3(J)=TELUR3(J)+(ELMEC3/TTELM3)*TELWR3
         TELWM3(J)=TELWM3(J)+TELED3-(ELMEC3/TTELM3)*TELWR3-TELWP3(J)
         ELMEC3=0.0
      END IF
```

```
TELRT3(J)=TIME +TELETR
TLUR3T=TLUR3T+TELUR3(J)
TLWP3T=TLWP3T+TELWP3(J)
TLWM3T=TLWM3T+TELWM3(J)
TELWL3=TLWM3T*TELEMH
```

6. WORKLOAD COMPUTATIONS

These algorithms calculate the maintenance workload at the two maintenance contact teams and evacuate any repair work which exceeds their capability to return in a given timeframe to the DS maintenance company in the rear.

```
26    TACWL1=TENWL1+TXMWL1+TXFWL1+TFDWL1+TTRWL1
      FCCWL1=TFCWL1
      ARCWL1=TARWL1
      ELCWL1=TELWL1
      TACWL2=TENWL2+TXMWL2+TXFWL2+TFDWL2+TTRWL2
      FCCWL2=TFCWL2
      ARCWL2=TARWL2
      ELCWL2=TELWL2
```

Tank track evacuations

```
IF(TACWL1.LE.TM1AWL)GO TO 40
OVERL=TACWL1-TM1AWL
IF(OVERL.GT.TTRWL1)THEN
   TTETR1(J)=TTWM1T
   TTWM1T=0.0
   TACWL1=TACWL1-TTRWL1
   TTRWL=0.0
ELSE
   TTETR1(J)=OVERL/TTRKMH
   TTWM1T=TTWM1T-TTETR1(J)
   TTRWL1=TTRWL1-OVERL
   TACWL1=TM1AWL
END IF
```

Tank final drive evacuations

```
IF(TACWL1.LE.TM1AWL)GO TO 40
OVERL=TACWL1-TM1AWL
IF(OVERL.GT.TFDWL1)THEN
```

```
    TDETR1(J)=TDWM1T
    TDWM1T=0.0
    TACWL1=TACWL1-TFDWL1
    TFDWL1=0.0
  ELSE
    TDETR1(J)=OVERL/TFDRMH
    TDWM1T=TDWM1T-TDETR1(J)
    TFDWL1=TFDWL1-OVERL
    TACWL1=TM1AWL
  END IF
```

Tank transfer evacuations

```
  IF(TACWL1.LE.TM1AWL)GO TO 40
  OVERL=TACWL1-TM1AWL
  IF(OVERL.GT.TXFWL1)THEN
    TFETR1(J)=TFWM1T
    TFWM1T=0.0
    TACWL1=TACWL1-TXFWL1
    TXFWL1=0.0
  ELSE
    TFETR1(J)=OVERL/TXFRMH
    TFWM1T=TFWM1T-TFETR1(J)
    TXFWL1=TXFWL1-OVERL
    TACWL1=TM1AWL
  END IF
```

Tank transmission evacuations

```
  IF(TACWL1.LE.TM1AWL)GO TO 40
  OVERL=TACWL1-TM1AWL
  IF(OVERL.GT.TXMWL1)THEN
    TXETR1(J)=TXWM1T
    TXWM1T=0.0
    TACWL1=TACWL1-TXMWL1
    TXMWL1=0.0
  ELSE
    TXETR1(J)=OVERL/TXMNMH
    TXWM1T=TXWM1T-TXETR1(J)
    TXMWL1=TXMWL1-OVERL
    TACWL1=TM1AWL
  END IF
```

Tank engine evacuations

```
  IF(TACWL1.LE.TM1AWL)GO TO 40
  OVERL=TACWL1-TM1AWL
  IF(OVERL.GT.TENWL1)THEN
    TEETR1(J)=TEWM1T
    TEWM1T=0.0
```

```
         TACWL1=TACWL1-TENWL1
         TENWL1=0.0
      ELSE
         TEETR1(J)=OVERL/TENGMH
         TEWM1T=TEWM1T-TEETR1(J)
         TENWL1=TENWL1-OVERL
         TACWL1=TM1AWL
      END IF
```

Tank fire control system evacuations

```
40    IF(FCCWL1.LE.FM1AWL)GO TO 41
      OVERL=FCCWL1-FM1AWL
      IF(OVERL.GT.TFCWL1)THEN
         TCETR1(J)=TCWM1T
         TCWM1T=0.0
         FCCWL1=FCCWL1-TFCWL1
         TFCWL1=0.0
      ELSE
         TCETR1(J)=OVERL/TFCNMH
         TCWM1T=TCWM1T-TCETR1(J)
         TFCWL1=TFCWL1-OVERL
         FCCWL1=FM1AWL
      END IF
```

Tank armament system evacuations

```
41    IF(ARCWL1.LE.AM1AWL)GO TO 42
      OVERL=ARCWL1-AM1AWL
      IF(OVERL.GT.TARWL1)THEN
         TAETR1(J)=TAWM1T
         TAWM1T=0.0
         ARCWL1=ARCWL1-TARWL1
         TARWL1=0.0
      ELSE
         TAETR1(J)=OVERL/TARMMH
         TAWM1T=TAWM1T-TAETR1(J)
         TARWL1=TARWL1-OVERL
         ARCWL1=AM1AWL
      END IF
```

Tank electrical system evacuations

```
42    IF(ELCWL1.LE.EM1AWL)GO TO 43
      OVERL=ELCWL1-EM1AWL
      IF(OVERL.GT.TELWL1)THEN
         TLETR1(J)=TLWM1T
         TLWM1T=0.0
         ELCWL1=ELCWL1-TELWL1
         TELWL1=0.0
```

```
      ELSE
         TLETR1(J)=OVERL/TELEMH
         TLWM1T=TLWM1T-TLETR1(J)
         TELWL1=TELWL1-OVERL
         ELCWL1=EM1AWL
      END IF
```

This section of code calculates the evacuated components from the 2nd MST

```
43    IF(TACWL2.LE.TM2AWL)GO TO 45
      OVERL=TACWL2-TM2AWL
      IF(OVERL.GT.TTRWL2)THEN
         TTETR2(J)=TTWM2T
         TTWM2T=0.0
         TACWL2=TACWL2-TTRWL2
         TTRWL=0.0
      ELSE
         TTETR2(J)=OVERL/TTRKMH
         TTWM2T=TTWM2T-TTETR2(J)
         TTRWL2=TTRWL2-OVERL
         TACWL2=TM2AWL
      END IF

      IF(TACWL2.LE.TM2AWL)GO TO 45
      OVERL=TACWL2-TM2AWL
      IF(OVERL.GT.TFDWL2)THEN
         TDETR2(J)=TDWM2T
         TDWM2T=0.0
         TACWL2=TACWL2-TFDWL2
         TFDWL2=0.0
      ELSE
         TDETR2(J)=OVERL/TFDRMH
         TDWM2T=TDWM2T-TDETR2(J)
         TFDWL2=TFDWL2-OVERL
         TACWL2=TM2AWL
      END IF

      IF(TACWL2.LE.TM2AWL)GO TO 45
      OVERL=TACWL2-TM2AWL
      IF(OVERL.GT.TXFWL2)THEN
         TFETR2(J)=TFWM2T
         TFWM2T=0.0
         TACWL2=TACWL2-TXFWL2
         TXFWL2=0.0
      ELSE
         TFETR2(J)=OVERL/TXFRMH
         TFWM2T=TFWM2T-TFETR2(J)
         TXFWL2=TXFWL2-OVERL
```

```
         TACWL2=TM2AWL
      END IF

      IF(TACWL2.LE.TM2AWL)GO TO 45
      OVERL=TACWL2-TM2AWL
      IF(OVERL.GT.TXMWL2)THEN
         TXETR2(J)=TXWM2T
         TXWM2T=0.0
         TACWL2=TACWL2-TXMWL2
         TXMWL2=0.0
      ELSE
         TXETR2(J)=OVERL/TXMNMH
         TXWM2T=TXWM2T-TXETR2(J)
         TXMWL2=TXMWL2-OVERL
         TACWL2=TM2AWL
      END IF

      IF(TACWL2.LE.TM2AWL)GO TO 45
      OVERL=TACWL2-TM2AWL
      IF(OVERL.GT.TENWL2)THEN
         TEETR2(J)=TEWM2T
         TEWM2T=0.0
         TACWL2=TACWL2-TENWL2
         TENWL2=0.0
      ELSE
         TEETR2(J)=OVERL/TENGMH
         TEWM2T=TEWM2T-TEETR2(J)
         TENWL2=TENWL2-OVERL
         TACWL2=TM2AWL
      END IF


45    IF(FCCWL2.LE.FM2AWL)GO TO 46
      OVERL=FCCWL2-FM2AWL
      IF(OVERL.GT.TFCWL2)THEN
         TCETR2(J)=TCWM2T
         TCWM2T=0.0
         FCCWL2=FCCWL2-TFCWL2
         TFCWL2=0.0
      ELSE
         TCETR2(J)=OVERL/TFCNMH
         TCWM2T=TCWM2T-TCETR2(J)
         TFCWL2=TFCWL2-OVERL
         FCCWL2=FM2AWL
      END IF
```

```
46     IF(ARCWL2.LE.AM2AWL)GO TO 47
       OVERL=ARCWL2-AM2AWL
       IF(OVERL.GT.TARWL2)THEN
          TAETR2(J)=TAWM2T
          TAWM2T=0.0
          ARCWL2=ARCWL2-TARWL2
          TARWL2=0.0
       ELSE
          TAETR2(J)=OVERL/TARMMH
          TAWM2T=TAWM2T-TAETR2(J)
          TARWL2=TARWL2-OVERL
          ARCWL2=AM2AWL
       END IF

47     IF(ELCWL2.LE.EM2AWL)GO TO 48
       OVERL=ELCWL2-EM2AWL
       IF(OVERL.GT.TELWL2)THEN
          TLETR2(J)=TLWM2T
          TLWM2T=0.0
          ELCWL2=ELCWL2-TELWL2
          TELWL2=0.0
       ELSE
          TLETR2(J)=OVERL/TELEMH
          TLWM2T=TLWM2T-TLETR2(J)
          TELWL2=TELWL2-OVERL
          ELCWL2=EM2AWL
       END IF
```

7. EVACUATION TIME ROUTINES

These routines cycle through the evacuation time queues and determine which of the evacuated jobs from the two forward maintenance support teams have arrived at the DS maintenance company.

```
48     IF(J.EQ.1)THEN
       GO TO 402
       ELSE
       M=J-1
       END IF
```

```
      DO 992 K=1,J
C     Tank engines arrived
        IF(EVACT1(K).LE.TIME)THEN
        ETEWR1=TEETR1(K)
        ETENT1=ETENT1-TEETR1(K)
        TEETR1(K)=0.0
        ELSE
        END IF
C     Tank transmissions arrived
        IF(EVACT1(K).LE.TIME)THEN
        ETXWR1=TXETR1(K)
        ETXMT1=ETXMT1-TXETR1(K)
        TXETR1(K)=0.0
        ELSE
        END IF
C     Tank transfers arrived
        IF(EVACT1(K).LE.TIME)THEN
        ETFWR1=TFETR1(K)
        ETXFT1=ETXFT1-TFETR1(K)
        TFETR1(K)=0.0
        ELSE
        END IF
C     Tank track arrived
        IF(EVACT1(K).LE.TIME)THEN
        ETTWR1=TTETR1(K)
        ETTRT1=ETTRT1-TTETR1(K)
        TTETR1(K)=0.0
        ELSE
        END IF
C     Tank final drives arrived
        IF(EVACT1(K).LE.TIME)THEN
        ETDWR1=TDETR1(K)
        ETFDT1=ETFDT1-TDETR1(K)
        TDETR1(K)=0.0
        ELSE
        END IF
C     Tank fire control systems arrived
        IF(EVACT1(K).LE.TIME)THEN
```

```
ETCWR1=TCETR1(K)
ETFCT1=ETFCT1-TCETR1(K)
TCETR1(K)=0.0
ELSE
END IF
```

Tank armament systems arrived

```
IF(EVACT1(K).LE.TIME)THEN
ETAWR1=TAETR1(K)
ETART1=ETART1-TAETR1(K)
TAETR1(K)=0.0
ELSE
END IF
```

Tank electrical systems arrived

```
IF(EVACT1(K).LE.TIME)THEN
ETLWR1=TLETR1(K)
ETELT1=ETELT1-TLETR1(K)
TLETR1(K)=0.0
ELSE
END IF
```

The following section of code determines which components have arrived at the DS company from the 2nd MST

```
IF(EVACT2(K).LE.TIME)THEN
ETEWR2=TEETR2(K)
ETENT2=ETENT2-TEETR2(K)
TEETR2(K)=0.0
ELSE
END IF

IF(EVACT2(K).LE.TIME)THEN
ETXWR2=TXETR2(K)
ETXMT2=ETXMT2-TXETR2(K)
TXETR2(K)=0.0
ELSE
END IF

IF(EVACT2(K).LE.TIME)THEN
ETFWR2=TFETR2(K)
ETXFT2=ETXFT2-TFETR2(K)
TFETR2(K)=0.0
ELSE
END IF
```

```
      IF(EVACT2(K).LE.TIME)THEN
      ETTWR2=TTETR2(K)
      ETTRT2=ETTRT2-TTETR2(K)
      TTETR2(K)=0.0
      ELSE
      END IF

      IF(EVACT2(K).LE.TIME)THEN
      ETDWR2=TDETR2(K)
      ETFDT2=ETFDT2-TDETR2(K)
      TDETR2(K)=0.0
      ELSE
      END IF

      IF(EVACT2(K).LE.TIME)THEN
      ETCWR2=TCETR2(K)
      ETFCT2=ETFCT2-TCETR2(K)
      TCETR2(K)=0.0
      ELSE
      END IF

      IF(EVACT2(K).LE.TIME)THEN
      ETAWR2=TAETR2(K)
      ETART2=ETART2-TAETR2(K)
      TAETR2(K)=0.0
      ELSE
      END IF

      IF(EVACT2(K).LE.TIME)THEN
      ETLWR2=TLETR2(K)
      ETELT2=ETELT2-TLETR2(K)
      TLETR2(K)=0.0
      ELSE
      END IF

992   CONTINUE
```

8. OUTPUT GENERATION

The following statements format the output as given in Chapter 5.

```
      PRINT,' '
      PRINT,'-----------------------------------------------------------------'
      PRINT,'1ST BN MAINT SPT TEAM TANK STATUS REPORT AS OF',TIME
      PRINT,'-----------------------------------------------------------------'
      PRINT,'SYSTEM  NEW      UNDER  WAITING  WAITING   REPAIRS   PARTS'
      PRINT,'        DAMAGES  REPAIR  PARTS  MECHANICS COMPLETED ON HAND'
      PRINT,'-----------------------------------------------------------------'
      WRITE(6,900)TENGD1,TEUR1T,TEWP1T,TEWM1T,TENRR1(J),TENG1
900   FORMAT(1X,'ENG',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,901)TXMND1,TXUR1T,TXWP1T,TXWM1T,TXMRR1(J),TXMN1
901   FORMAT(1X,'XMN',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,902)TXFRD1,TFUR1T,TFWP1T,TFWM1T,TXFRR1(J),TXFR1
902   FORMAT(1X,'XFR',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,903)TTRKD1,TTUR1T,TTWP1T,TTWM1T,TTRRR1(J),TTRK1
903   FORMAT(1X,'TRK',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,904)TFCND1,TCUR1T,TCWP1T,TCWM1T,TFCRR1(J),TFCN1
904   FORMAT(1X,'FCN',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,905)TFDRD1,TDUR1T,TDWP1T,TDWM1T,TFDRR1(J),TFDR1
905   FORMAT(1X,'FDR',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,906)TARMD1,TAUR1T,TAWP1T,TAWM1T,TARRR1(J),TARM1
906   FORMAT(1X,'ARM',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,907)TELED1,TLUR1T,TLWP1T,TLWM1T,TELRR1(J),TELE1
907   FORMAT(1X,'ELE',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      PRINT,'-----------------------------------------------------------------'
      PRINT,' '
      PRINT,' '
      PRINT,' '
      PRINT,'2ND BN MAINT SPT TEAM TANK STATUS REPORT AS OF',TIME
      PRINT,'-----------------------------------------------------------------'
      PRINT,'SYSTEM  NEW      UNDER  WAITING  WAITING   REPAIRS   PARTS'
      PRINT,'        DAMAGES  REPAIR  PARTS  MECHANICS COMPLETED ON HAND'
      PRINT,'-----------------------------------------------------------------'
      WRITE(6,920)TENGD2,TEUR2T,TEWP2T,TEWM2T,TENRR2(J),TENG2
920   FORMAT(1X,'ENG',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,921)TXMND2,TXUR2T,TXWP2T,TXWM2T,TXMRR2(J),TXMN2
921   FORMAT(1X,'XMN',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,922)TXFRD2,TFUR2T,TFWP2T,TFWM2T,TXFRR2(J),TXFR2
922   FORMAT(1X,'XFR',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,923)TTRKD2,TTUR2T,TTWP2T,TTWM2T,TTRRR2(J),TTRK2
923   FORMAT(1X,'TRK',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,924)TFCND2,TCUR2T,TCWP2T,TCWM2T,TFCRR2(J),TFCN2
924   FORMAT(1X,'FCN',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,925)TFDRD2,TDUR2T,TDWP2T,TDWM2T,TFDRR2(J),TFDR2
```

```
925   FORMAT(1X,'FDR',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,926)TARMD2,TAUR2T,TAWP2T,TAWM2T,TARRR2(J),TARM2
926   FORMAT(1X,'ARM',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,927)TELED2,TLUR2T,TLWP2T,TLWM2T,TELRR2(J),TELE2
927   FORMAT(1X,'ELE',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      PRINT,'---------------------------------------------------------------------'
      PRINT,' '
      PRINT,' '
      PRINT,' '
      PRINT,' '
      PRINT,'DS MAINTENANCE COMPANY TANK STATUS REPORT AS OF',TIME
      PRINT,'---------------------------------------------------------------------'
      PRINT,'SYSTEM  NEW      UNDER  WAITING  WAITING    REPAIRS    PARTS'
      PRINT,'        DAMAGES  REPAIR  PARTS  MECHANICS COMPLETED ON HAND'
      PRINT,'---------------------------------------------------------------------'
      WRITE(6,940)TENGD3,TEUR3T,TEWP3T,TEWM3T,TENRR3(J),TENG3
940   FORMAT(1X,'ENG',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,941)TXMND3,TXUR3T,TXWP3T,TXWM3T,TXMRR3(J),TXMN3
941   FORMAT(1X,'XMN',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,942)TXFRD3,TFUR3T,TFWP3T,TFWM3T,TXFRR3(J),TXFR3
942   FORMAT(1X,'XFR',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,943)TTRKD3,TTUR3T,TTWP3T,TTWM3T,TTRRR3(J),TTRK3
943   FORMAT(1X,'TRK',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,944)TFCND3,TCUR3T,TCWP3T,TCWM3T,TFCRR3(J),TFCN3
944   FORMAT(1X,'FCN',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,945)TFDRD3,TDUR3T,TDWP3T,TDWM3T,TFDRR3(J),TFDR3
945   FORMAT(1X,'FDR',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,946)TARMD3,TAUR3T,TAWP3T,TAWM3T,TARRR3(J),TARM3
946   FORMAT(1X,'ARM',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      WRITE(6,947)TELED3,TLUR3T,TLWP3T,TLWM3T,TELRR3(J),TELE3
947   FORMAT(1X,'ELE',4X,F6.2,2X,F6.2,2X,F6.2,3X,F6.2,4X,F6.2,3X,F6.2)
      PRINT,'---------------------------------------------------------------------'
      PRINT,' '
      PRINT,' '
      PRINT,' '
      PRINT,'---------------------------------------------------------------------'
      PRINT,'      EVACUATED     EVACUATED     RECEIVED BY     RECEIVED BY'
      PRINT,'        FROM          FROM         DS  FROM        DS  FROM'
      PRINT,'       1ST BN        2ND BN         1ST BN          2ND BN'
      PRINT,'     (EN ROUTE)    (EN ROUTE)    AT THIS TIME    AT THIS TIME'
      PRINT,'---------------------------------------------------------------------'
      WRITE(6,50)ETENT1,ETENT2,ETEWR1,ETEWR2
50    FORMAT(1X,'ENG',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
      WRITE(6,51)ETXMT1,ETXMT2,ETXWR1,ETXWR2
51    FORMAT(1X,'XMN',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
      WRITE(6,52)ETXFT1,ETXFT2,ETFWR1,ETFWR2
52    FORMAT(1X,'XFR',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
      WRITE(6,53)ETFDT1,ETFDT2,ETDWR1,ETDWR2
53    FORMAT(1X,'FDR',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
      WRITE(6,54)ETTRT1,ETTRT2,ETTWR1,ETTWR2
```

```
54     FORMAT(1X,'TRK',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
       WRITE(6,55)ETFCT1,ETFCT2,ETCWR1,ETCWR2
55     FORMAT(1X,'FCN',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
       WRITE(6,56)ETART1,ETART2,ETAWR1,ETAWR2
56     FORMAT(1X,'ARM',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
       WRITE(6,57)ETELT1,ETELT2,ETLWR1,ETLWR2
57     FORMAT(1X,'ELE',3X,F6.2,7X,F6.2,8X,F6.2,9X,F6.2)
       PRINT,'------------------------------------------------------------'
       PRINT,' '
       PRINT,' '
       PRINT,'------------------------------------------------------------'
       PRINT,'TOTAL REPAIRS COMPLETED AS OF THIS TIME BY EACH'
       PRINT,'MAINTENANCE ELEMENT'
       PRINT,'---------------------------------------------------------- '
       PRINT,'SYSTEM      1ST BN MST      2ND BN MST     DS MAINT BN'
       PRINT,'---------------------------------------------------------- '
       WRITE(6,58)TERT1,TERT2,TERT3
58     FORMAT(1X,'ENG',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,59)TXRT1,TXRT2,TXRT3
59     FORMAT(1X,'XMN',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,60)TFRT1,TFRT2,TFRT3
60     FORMAT(1X,'XFR',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,61)TDRT1,TDRT2,TDRT3
61     FORMAT(1X,'FDR',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,62)TTRT1,TTRT2,TTRT3
62     FORMAT(1X,'TRK',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,63)TCRT1,TCRT2,TCRT3
63     FORMAT(1X,'FCN',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,64)TART1,TART2,TART3
64     FORMAT(1X,'ARM',10X,F6.2,10X,F6.2,9X,F6.2)
       WRITE(6,65)TLRT1,TLRT2,TLRT3
65     FORMAT(1X,'ELE',10X,F6.2,10X,F6.2,9X,F6.2)
11     CONTINUE
       STOP
       END
$ENTRY
```

APPENDIX B
ALGORITHM VARIABLES

This appendix lists and explains the algorithm variables utilized in the computer program and this thesis.

1. ALGORITHM VARIABLES

The letters and numbers of these algorithm variables relate directly to the function they are supposed to represent. As an example the first variable listed, TENWP, stands for /Tank/ENgine/Waiting Parts/. The numbers listed with these variable names in the program listing represent one of the three maintenance elements of the simulation. The numbers one and two represent the two maintenance support teams and the number three represents the DS maintenance company.

1. TENWP: The number of tanks damaged waiting for an engine
2. TXMWP: The number of tanks damaged waiting for a transmission
3. TXFWP: The number of tanks damaged waiting for a transfer
4. TTRWP: The number of tanks damaged waiting for track
5. TFCWP: The number of tanks damaged waiting for a fire control system
6. TARWP: The number of tanks damaged waiting for an armament system

7. TELWP: The number of tanks damaged waiting for an electrical system

8. TENUR: The number of tanks being repaired for an engine

9. TXMUR: The number of tanks being repaired for a transmission

10. TXFUR: The number of tanks being repaired for a transfer

11. TTRUR: The number of tanks being repaired for track

12. TFDUR: The number of tanks being repaired for a final drive

13. TFCUR: The number of tanks being repaired for a fire control system

14. TARUR: The number of tanks being repaired for an armament system

15. TELUR: The number of tanks being repaired for an electrical system

16. TENRR: The time when tanks damaged for an engine will be repaired and returned

17. TXMRR: The time when tanks damaged for a transmission will be repaired and returned

18. TXFRR: The time when tanks damaged for a transfer will be repaired and returned

19. TTRRR: the time when tanks damaged for track will be repaired and returned

20. TFDRR: the time when tanks damaged for final drive will be repaired and returned

21. TFCRR: the time when tanks damaged for a fire control system will be repaired and returned

22. TARRR: the time when tanks damaged for an armament system will be repaired and returned

23. TELRR: the time when tanks damaged for an electrical system will be repaired and returned

24. TENWM: the number of tanks being repaired for an engine

25. TXMWM: the number of tanks being repaired for a transmission that are waiting for mechanics

26. TXFWM: the number of tanks being repaired for a transfer that are waiting for mechanics

27. TTRWM: the number of tanks being repaired for track that are waiting for mechanics

28. TFDWM: the number of tanks being repaired for final drives that are waiting for mechanics

29. TFCWM: the number of tanks being repaired for a fire control system that are waiting for mechanics

30. TARWM: the number of tanks being repaired for an armament system that are waiting for mechanics

31. TELWM: the number of tanks being repaired for an electrical system that are waiting for mechanics

32. TENRT: The time when tanks damaged for an engine will be completed

33. TXMRT: The time when tanks damaged for a transmission will be completed

34. TXFRT: The time when tanks damaged for a transfer will be completed

35. TTRRT: the time when tanks damaged for track will be completed

36. TFDRT: the time when tanks damaged for final drive will be completed

37. TFCRT: the time when tanks damaged for a fire control system will be completed

38. TARRT: the time when tanks damaged for an armament system will be completed

39. TELRT: the time when tanks damaged for an electrical system will be completed

40. TENG: tank engines on-hand

41. TXMN: tank transmissions on-hand

42. TXFR: tank transfers on-hand

43. TFDR: tank final drives on-hand

44. TTRK: tank track on-hand

45. TFCN: tank fire control systems on-hand

46. TARM: tank armament systems on-hand

47. TELE: tank electrical systems on-hand

48. TENGD: tank engines damaged

49. TXMND: tank transmissions damaged

50. TXFRD: tank transfers damaged

51. TFDRD: tank final drives damaged

52. TTRKD: tank track damaged

53. TFCND: tank fire control systems damaged

54. TARMD: tank armament systems damaged

55. TELED: tank electrical systems damaged

56. TTENM: total tank engine mechanics required

57. TTXMM: total tank transmission mechanics required

58. TTXFM: total tank transfer mechanics required

59. TTFDM: total tank final drive mechanics required

60. TTTRM: total tank track mechanics required
61. TTARM: total tank armament mechanics required
62. TTFCM: total tank fire control mechanics required
63. TTELM: total tank electrical mechanics required
64. TEETR: tank engine repairs evacuated to the rear
65. TXETR: tank transmission repairs evacuated to the rear
66. TFETR: tank transfer repairs evacuated to the rear
67. TDETR: tank final drive repairs evacuated to the rear
68. TTETR: tank track repairs evacuated to the rear
69. TAETR: tank armament repairs evacuated to the rear
70. TCETR: tank fire control repairs evacuated to the rear
71. TLETR: tank electrical repairs evacuated to the rear
72. TAMEC: tracked vehicle mechanic
73. ARMEC: armament mechanic
74. FCMEC: fire control mechanic
75. ELMEC: electrical mechanic
76. TEUR1T: total tank engines under repair at MST 1
77. TXUR1T: total tank transmissions under repair at MST 1
78. TFUR1T: total tank transfers under repair at MST 1
79. TDUR1T: total tank final drives under repair at MST 1
80. TTUR1T: total tank track under repair at MST 1
81. TAUR1T: total tank armament systems under repair at MST 1
82. TCUR1T: total tank fire control systems under repair at MST 1
83. TLUR1T: total tank electrical systems under repair at MST 1
84. TACWL: tracked mechanic current workload
85. TM1AWL: tracked mechanic allowable workload
86. ARCWL: armament mechanic current workload
87. AR1AWL: armament mechanic allowable workload
88. FCCWL: fire control mechanic current workload
89. FC1AWL: fire control mechanic allowable workload
90. ELCWL: electrical mechanic current workload
91. EL1AWL: electrical mechanic allowable workload

LIST OF REFERENCES

1. Hartman, James K., Parry, Samuel H., and Schoenstadt, Arthur L., Airland Research Model, paper presented to MORS, Naval Postgraduate School, Monterey, California, June, 1984.

2. Kilmer, R., Target Value Analysis Approach for the Airland Research Model, Master's thesis, Naval Postgraduate School, Monterey, California, March 1986.

3. Catalog of War Games, Training Games and Combat Simulations, Deputy Undersecretary of the Army for Operations Research, Washington, D.C., November, 1983.

4. YU V. Chuyev, Research of Military Operations, Military Publishing House, Moscow, April, 1970 translated June, 1971.

5. Fishman, George S., Principles of Discrete Event Simulation, Wiley and Sons, 1978.

6. Conover, W. J., Practical Nonparametric Statistics, Wiley and Sons, 1980.

7. Venttsel, Ye S., Introduction to Operations Research, Soviet Radio Publishing House, Moscow, 1964.

8. Tkachenko, P. N., Mathematical Models of Combat Operations, Translated by US Army Foreign Science and Technology Center, April, 1973.

9. United States Army Field Manual 100-10, Combat Service Support, 1 March 1983.

10. United States Army Field Manual, Operations, 20 August 1982.

11. United States Army Field Manual 29-12, Division Maintenance Operations, 9 May 1983.

12. Schoenstadt, Arthur L., Toward an Axiomatic Generalized Value System, unpublished paper, Naval Postgraduate School, Monterey, California, June, 1984.

13. United States Army Training and Doctrine Command Pamphlet 525-27-1, U.S. Army Operational Concept for Forward Support Maintenance, 10 March 1983.

14. United States Army Concepts Analysis Agency, FORCEM Model Design Objectives: Annex A: FORCEM Combat Service Support, 25 June 1982.

15. The RAND Corporation, AURA User's Manual: Volume I, Program Features and Interactions, by Robert Shisko and Milton Kamins, June 1983.

16. United States Army Command and General Staff College Reference Book (RB) 101-999(Test), Staff Officer's Handbook, December 1981.

17. Combat Data Information Center, AFWAL/SURVIAC, South East Asia Ground Vehicle Data Base, Wright-Patterson AFB, Ohio, November 1985.

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